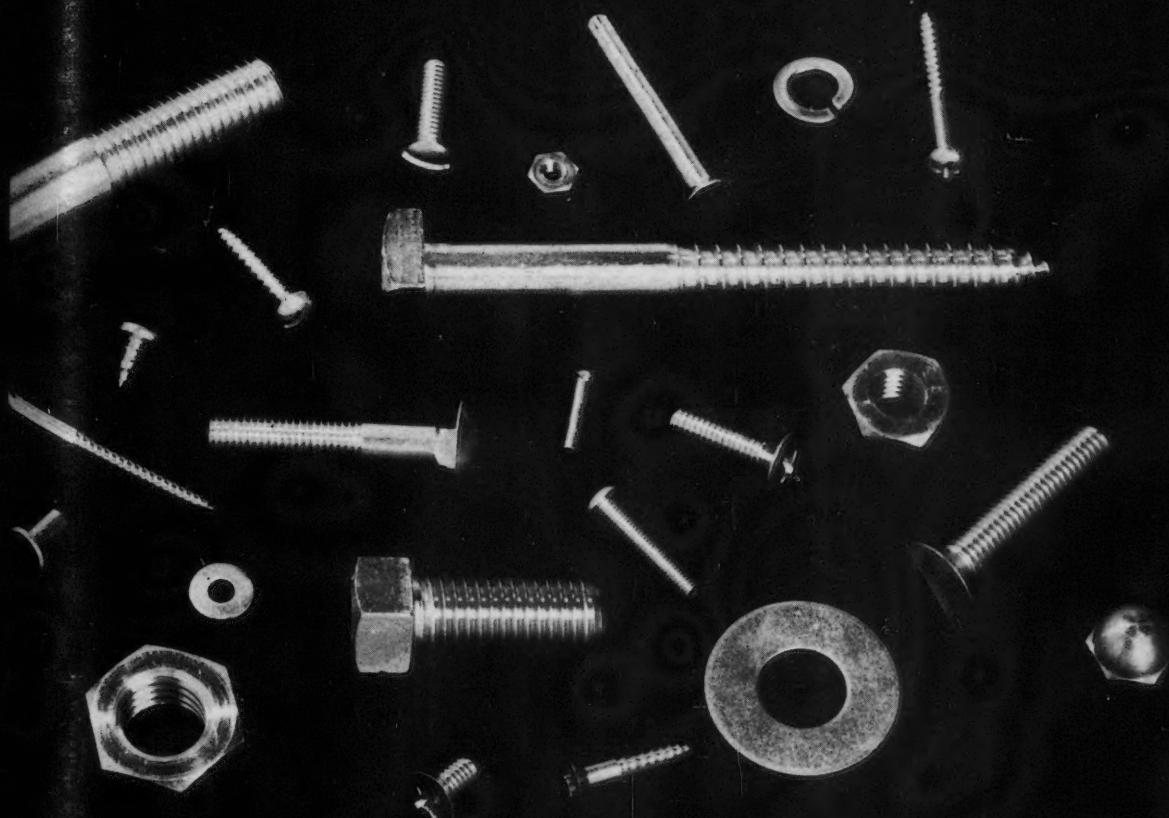
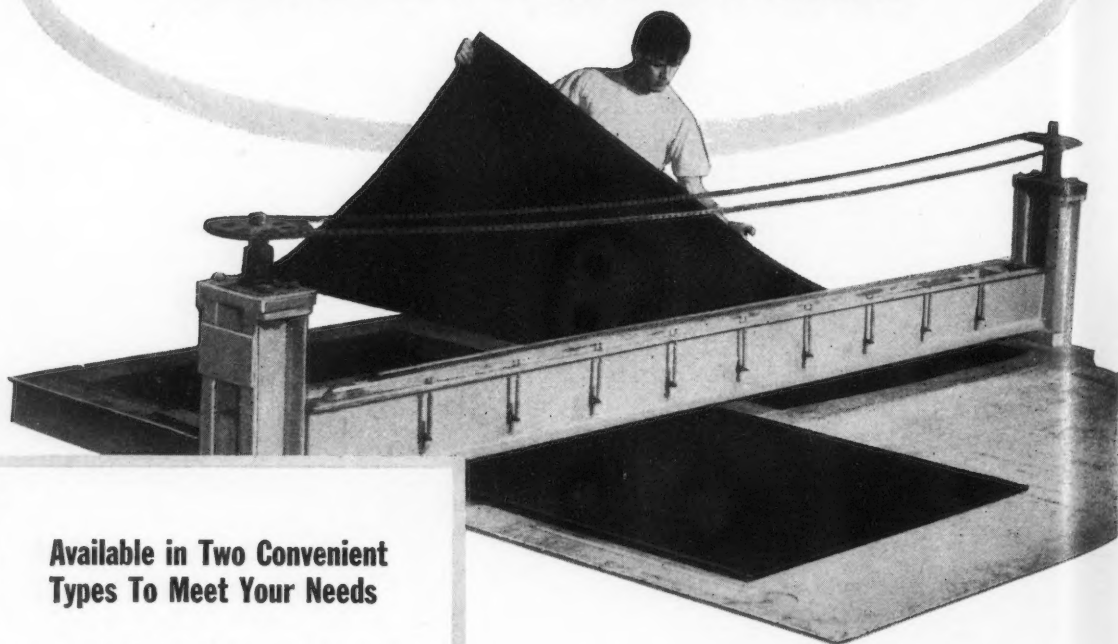


Corrosion



FOR THOSE EXTREMELY CORROSIVE CONDITIONS...

CONSIDER THE USE OF *Amer-Plate*



Available in Two Convenient Types To Meet Your Needs

Plain AMER-PLATE for existing steel or concrete tanks or structures

Plain Amer-Plate is smooth and flat on both sides. It is applied to existing surfaces using specially developed cements that provide a firm bond with those surfaces.



T-LOCK AMER-PLATE for newly cast concrete pipe and structures

T-shaped parallel "anchors" are an integral part and extend along the back of each Amer-Plate sheet. The sheet is applied to the inner forms of tanks, concrete pipe, and structures. When the concrete is poured, the tees are embedded and locked into the concrete.



HERE'S A NEW, EXTRA-TOUGH, ECONOMICAL INDUSTRIAL SHEET LINING

Especially designed to protect against extremely corrosive conditions, Amer-Plate is particularly adaptable for use in highly corrosive sewers, chemical storage tanks, tank cars and tank trucks hauling unusually corrosive solutions.

Composed of inert resins and plasticizers, Amer-Plate is impervious to gases, highly resistant to acids, alkalies, alcohol, oils, salts, and petroleum products. It has a very low moisture vapor transmission rate, will not support combustion, and contains no toxic materials.

Amer-Plate is a flexible thermoplastic sheet, practical for application to flat, curved and angular surfaces. Its economy and effectiveness has been proved in the field in over 10 years of development and testing.

So... wherever you require long lasting protection against extreme corrosion, make a full investigation of the possibility of using Amer-Plate. Write for complete information.

Amer-Plate industrial sheet lining is the result of many years experience in the manufacture and application of Amercoat protective coatings.

AMERCOAT CORPORATION

A division of American Pipe and Construction Co.
4809 Firestone Blvd., South Gate, California

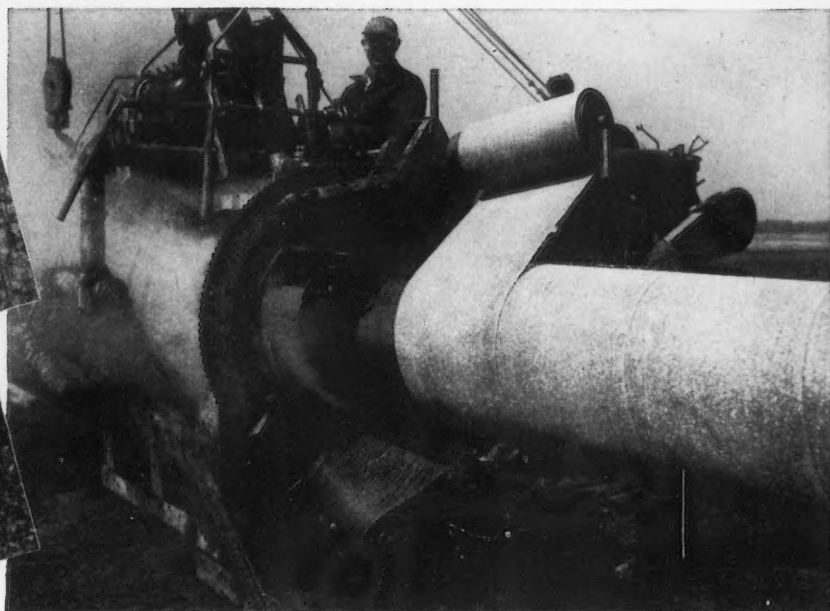
PARTNERS...



in PIPELINE PROTECTION

VITRON REINFORCING WRAP

VITRON OUTER WRAP



A strong, inorganic reinforcing for enamels plus a rugged protective outer wrap—these are the perfect partners in pipeline protection.

Porous **Vitron Reinforcing Wrap** pulls into the hot coatings, breaks up air bubbles and minimizes holidays, and provides permanent high strength reinforcing that's unaffected by moisture and soil acids.

Vitron Outer Wrap—made from an asphalt and tar compound, reinforced with glass fiber mat and yarn—provides a tough "hide" to protect coatings against handling, backfill and soil stress.

If you want these protection partners to work for you, write us for information. Glass Fibers Inc., 1810 Madison Avenue, Toledo 2, Ohio.



**UNDERGROUND
PIPE WRAPS**

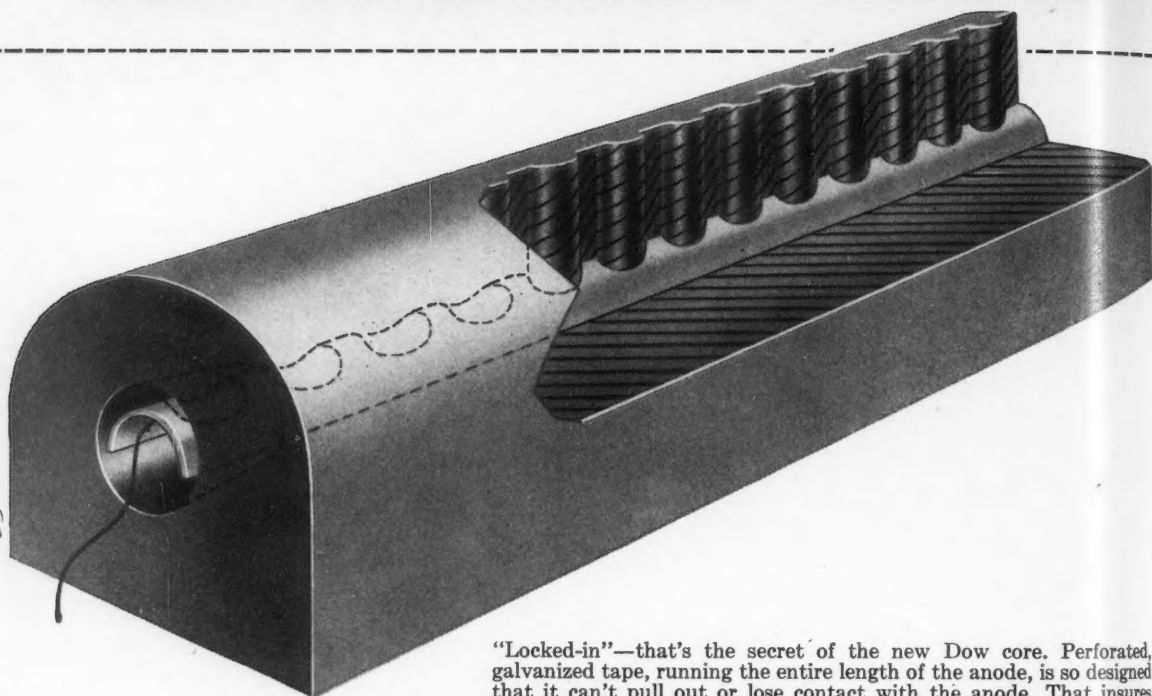
CORROSION—September, 1952

GLASS FIBERS INC.

Makers of glass fibers by the ELECTRONIC-EXTRUSION process
... developed, patented and used exclusively by Glass Fibers Inc.



New "locked-in" core assures maximum efficiency in **DOW MAGNESIUM ANODES**



**Plus
new shape
for special
applications!**

"Locked-in"—that's the secret of the new Dow core. Perforated, galvanized tape, running the entire length of the anode, is so designed that it can't pull out or lose contact with the anode. That insures long life, high efficiency. This new core is another first by Dow in the field of magnesium anodes.

Another feature of great interest is the new shape of Dow magnesium anodes. Employment of a different casting technique has resulted in a greater size flexibility than ever before available. It is now possible to order anodes that are practically "custom-tailored" to meet your specific requirements. The shape of the anode has changed from the tapered "D" to a "D" shape of uniform cross section. This makes possible a wide range of lengths for special applications at little or no extra cost. Of course, Dow will continue to make the standard size anodes that have been popular so long—with the new core.

Place your order today and take advantage of these new features that mean better protection at lower cost for you!

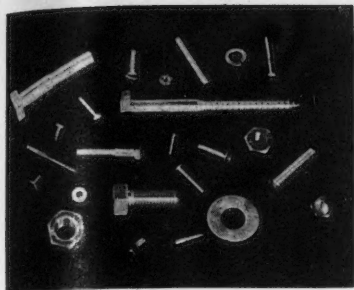
Contact the nearest Dow Sales Office or one of the Dow Magnesium Anode Distributors listed below!

DOW SALES OFFICES: Atlanta • Boston • Chicago • Cleveland • Detroit
Houston • Los Angeles • New York • Philadelphia • San Francisco
Seattle • St. Louis

AUTHORIZED DISTRIBUTORS: ANTI-CORROSION MFG. CO., Atlanta, Georgia
• CATHODIC PROTECTION SERVICE, Houston, Texas • DOWELL INCORPORATED,
Tulsa, Oklahoma • ELECTRO-RUSTPROOFING CORP., Belleville, N. J. • STUART
STEEL PROTECTION CORP., Plainfield, N. J. • THE VANODE CO., Pasadena, California.

THE DOW CHEMICAL COMPANY
Magnesium Department • Midland, Michigan





THIS MONTH'S COVER—This assortment of aluminum fasteners and washers manufactured by The H. M. Harper Company, 8221 Lehigh Ave., Morton Grove, Ill., is indicative of the rapidly expanding use of this metal's corrosion resisting characteristics for many structural uses. Engineers and architects with corrosion know how specify the correct fasteners and components for specific uses and no longer rely on steel alone. The Harper Company also makes a variety of high and low alloy fasteners.



EDITORIAL STAFF

IVY M. PARKER—*Editor*

EDITORIAL REVIEW COMMITTEE

GEORGE DIEHLMAN, *Chairman*

THOMAS P. MAY

J. W. RYZNAR

F. N. ALQUIST

ARTHUR W. TRACY

CORRESPONDENTS

C. L. BULOW—*Non-Ferrous Metals*

R. W. FLOURNOY—*Pulp, Paper, Mining and Food*

J. J. HALBIG—*Ferrous Metals*

W. E. HUDDLESTON—*Petroleum Production and Pipe Lines*

IRWIN C. DIETZE—*Power*

GUSTAVE HEINEMANN—*Chemical Process*

R. H. BROWN—*Light Metals*

DERK HOLSTEYN—*Petroleum Refining*

H. O. SAUNDERS, JR.—*Telephone, Telegraph, Radio*

R. MCFARLAND—*Non-Metals*

L. M. MOSIER—*Transportation Industry*

T. E. LARSON—*Fresh and Salt Water*

E. A. TICE—*Editor of "Corrosion Problems"*

BUSINESS STAFF

NORMAN E. HAMNER, *Managing Editor and Advertising Manager*

A. B. CAMPBELL (*Executive Secretary NACE*) *Business Manager*



GENERAL OFFICES

1061 M & M Building, No. 1 Main St.
Houston 2, Texas

Subscription: \$7.50 per year to non-members; Member's dues \$7.50, of which \$3.75 are applied as subscription to *Corrosion*; Special rate, \$3.50 per year for public libraries and libraries of educational institutions. Additional copies to members 50 cents, to non-members, 75 cents. Foreign remittances should be by international postal or express money order or bank draft negotiable in the U. S. for an equivalent amount in U. S. funds. Entered as second class matter October 31, 1946, at the Post Office at Houston, Texas, under the act of March 3, 1879.

Corrosion is Indexed Regularly by Engineering Index.

Corrosion

devoted entirely to
CORROSION
research and control

Published monthly as its official journal, by the National Association of Corrosion Engineers, Inc., at Houston, Texas, U. S. A., as a permanent record of progress in corrosion control.

Vol. 8

SEPTEMBER, 1952

No. 9



CONTENTS

Directory of NACE Regional and Sectional Officers	Page iv, v
Directory of Technical Practices Committees	viii, ix
Officers and Directors, NACE	xvi

TECHNICAL SECTION

Technical Practices Committee 1—Corrosion in Oil and Gas Well Equipment	
By H. L. Bilhartz	293
Corrosion Control in Gas-Lift Wells	
By D. A. Shock and J. D. Sudbury	296
Potential Measurements in Cathodic Protection Designs	
By Robert P. Howell	300
The Role of Oxygen in Corrosion and Cathodic Protection	
By Roy V. Comeaux	305
Discussion: Fred M. Cloninger, Page 310	
An Improved Electrolysis Switch	
By Vernon B. Pike	311
Discussion: H. G. Burd, Page 322	
Cathodic Protection at Steam-Electric Generating Stations	
By J. H. Collins and E. H. Thalmann	314
A Flow Control Device for Gravity-Feed Lubricators	
By J. A. Caldwell	321

DISCUSSIONS

Some Observations of the Potentials of Stainless Steels in Flowing Sea Water by K. M. Huston and R. B. Teel.	
Discussion by Norman Hackerman	322
Reply by K. M. Huston, Page 322	
Corrosion by Fluorine and Fluorine Compounds by Ralph Landau.	
Discussion by E. N. Skinner, Jr., Hugh P. Godard, Howard Bennett and Wayne Z. Friend.	322
Replies by Ralph Landau, Page 322	

NACE REGIONAL AND SECTIONAL NEWS

	Page		Page
Rogers, Wachter and Brannon Nominated	2	Annual Shreveport Short Course	
NACE Calendar	2	To Be Held September 18-19	4
NACE Membership in Canada Up	2	South Central Meeting Pipe Liners Forum Set	4
Pittsburgh Section Names Officers	3	South Central Meeting Program	
Detrick Elected Head of Cleveland Section	3	Changes Are Made	6
Southwestern Ohio Headed by McDuffie	3	Continuous Motion Pictures Planned for New Orleans Meeting	6
Western Region Plans Conference	3	Nine Meetings Are Scheduled by Greater St. Louis Section	22

GENERAL NEWS OF CORROSION INTEREST

	Page		Page
Topic of The Month—All Metal Containers Replace Wooden Ones for Aircraft Engines	1	Evaporation Techniques Aid Electrodeposition	8
Subcommittee Heads Named for TP-18	3	Book Reviews	10
Hayward Heads TP-14	3	Corrosion Damage to Piers Checked With Radioactive Isotope	10
Two Changes Made in TP-5 Officials	4	Corrosion Meetings	12
Co-Chairmen for Seven Events in Chicago Meeting Program Named	4	Major Improvement in Rectifiers Is Claimed for Titanium Dioxide Unit	14
78 Plan to Exhibit	4	NACE New Members and Address Changes	18
Corrosion Problems	5	New Products	23
		Personals	30

INDEX TO CORROSION ABSTRACTS	31
INDEX TO ADVERTISERS	47

Copyright 1952 by the National Association of Corrosion Engineers. Reproduction of the contents, either as a whole or in part, is forbidden unless specific permission has been obtained from the Editor of *Corrosion*. Articles presented represent the opinions of their authors, and not necessarily those of the Editors of *Corrosion*, nor the Officers or Members of the National Association of Corrosion Engineers. Manuscripts to be considered for publication should be forwarded, together with illustrations, to the Editor of *Corrosion*, 1061 M & M Building, Houston 2, Texas.

Directory of NACE Regional and Sectional Officers

NORTH EAST REGION

L. B. DONOVAN, Director
Consolidated Edison Co.
of New York, Inc.
4 Irving Place
New York City.

T. P. MAY, Chairman
The International Nickel
Co., Inc.
67 Wall St.
New York 5, N. Y.

GEORGE E. BEST, Vice-Chair.
Mutual Chemical Co. of America
1348 Block St.
Baltimore 31, Maryland

H. W. DIECK, Secretary-Treas.
Long Island Lighting Co.
250 Old Country Rd.
Mineola, N. Y.

Baltimore Section

GEORGE E. BEST, Chairman
Mutual Chemical Co. of America
1348 Block St.
Baltimore 31, Maryland

L. G. VON LOSSBERG, Vice-Chair.
c/o Sheppard T. Powell,
Cons. Chem. Engr.
330 North Charles
Baltimore 1, Maryland

A. L. ALEXANDER, Sec.-Treas.
Naval Research Laboratory
Washington, D. C.

Greater Boston Section

EDWIN J. TITSWORTH, Chair.
Koppers Co., Inc., Tar
Products Division
250 Stuart St.
Boston 16, Mass.

JOHN SWIFT, Vice-Chairman
Arthur D. Little, Inc.
30 Memorial Drive
Cambridge 42, Mass.

J. D. BIRD, Sec.-Treas.
The Dampney Co.
1243 River, Hyde Park
Boston 36, Mass.

Metropolitan Section (N. Y.)

KEMPTON H. ROLL, Chairman
Lead Industries Ass'n
420 Lexington Ave.
New York 17, N. Y.

GEORGE C. HULL, JR., Vice-Chair.
Anglo-American Varnish Co.
55 Johnson St.
Newark 5, N. J.

F. J. LoFEBVRE, Sec.-Treas.
Electro Rust-Proofing Corp.
Box 178
Newark 1, N. J.

Philadelphia Section

W. RONALD BRIGGS, Chair.
W. A. Briggs Bitumen Co.
3383 Richmond St.
Philadelphia 34, Pa.

EDWARD G. BRINK, Vice-Chair.
American Viscose Corp.
Rhoads Lane
R.F.D. 16
Media, Pa.

JOHN S. PETTIBONE, Sec.-Treas.
American Soc. for Testing Mat.
1916 Race St.
Philadelphia 3, Pa.



Pittsburgh Section

N. P. PEIFER, Chairman
Manufacturers Light &
Heat Company
2202 Vodeli St.
Pittsburgh 16, Pa.

N. T. SHIDELER, Vice-Chair.
Pittsburgh Coke & Chemical
Corporation
Neville Island,
Pittsburgh 25, Pa.

F. E. COSTANZO, Sec.
Manufacturers Light &
Heat Company
2202 Vodeli St.
Pittsburgh 16, Pa.

W. W. BINGER, Treasurer
Aluminum Co. of America
Research Laboratories
Box 772
New Kensington, Pa.

Western New York Section

WILLIAM O. BINDER, Chair.
Research Laboratories
Union Carbide & Carbon Corp.
Niagara Falls, N. Y.

J. E. SHIELDS, Vice-Chair.
Alox Corp.
3943 Buffalo Ave.
Niagara Falls, N. Y.

PAUL R. GUENTHER, Sec.-Treas.
Socony-Vacuum Oil Co., Inc.
503 Elk Street
Buffalo 5, N. Y.

NORTH CENTRAL REGION

FRANK L. WHITNEY, JR., Dir.
Monsanto Chemical Co.
1700 S. Second St.
St. Louis, Mo.

JACK H. LoPRETE, Chair.
Spray-Coat Engineers
775 S. Bayside St.
Detroit 25, Mich.

NORMAN A. KERSTEIN, Vice-Chair.
Detroit Edison Co.
2000 Second Ave.
Detroit 26, Mich.

JAMES F. HIRSHFELD, Sec.-Treas.
Hinchman Corp.
1208 Francis Palms Bldg.
Detroit 1, Mich.

Chicago Section

C. A. VAN NATTA, Chairman
Plastic Lining Coatings
900-02 South Wabash Ave.
Chicago 5, Ill.

L. W. EWING, Vice-Chairman
Standard Oil Co. of Indiana
Pipe Line Dept.
910 Michigan Ave.
Chicago, Ill.

R. I. LINDBERG, Sec.
Sinclair Research Laboratories,
Inc.
400 E. Sibley Blvd.
Harvey, Ill.

H. W. DIAMOND, Treas.
Morton Salt Co.
120 S. LaSalle St.
Chicago, Ill.

Cleveland Section

C. N. DETRICK, Chairman
Williams & Co., Inc.
3700 Perkins Ave.
Cleveland, Ohio

W. E. BAKER, Vice-Chair.
Standard Oil Co. of Ohio
606 Standard Bldg.
Cleveland 13, Ohio

H. W. HOSFORD, JR., Sec.-Treas.
Harco Corp.
Box 7026
Cleveland 28, Ohio

Detroit Section

JACK H. LoPRETE, Chairman
Spray-Coat Engineers Inc.
775 So. Bayside St.
Detroit 25, Michigan

LEON D. COOK, JR., Vice-Chair.
Wyandotte Chemicals Corp.
North Plant
Wyandotte, Michigan

PROCTOR G. COATES, Sec.
Michigan Bell Telephone Co.
618 Boulevard Bldg.
7310 Woodward St.
Detroit 2, Michigan

W. R. CAVANAGH, Treas.
Parker Rust Proof Co.
2177 E. Milwaukee St.
Detroit 11, Michigan

Eastern Wisconsin Section

HAROLD F. HAASE, Chair.
2917 West Juneau Ave.
Milwaukee 8, Wis.

IRVING S. LEVINSON, Vice-Chair.
Process Industries
Ampco Metal, Inc.
Milwaukee 46, Wis.

R. E. WICEN, Sec.-Treas.
Chain Belt Co. of Milwaukee
1600 West Bruce St.
Milwaukee 4, Wis.

Greater St. Louis Section

WAYNE H. KELLER, Chair.
Mallinckrodt Chemical Works
65 Destrehan
St. Louis, Mo.

OTTO H. FENNER, Vice-Chair.
Monsanto Chemical Co.
1700 S. Second St.
St. Louis, Mo.

ANDREW T. PICKENS, Sec.
C. K. Williams & Co.
2001 Lynch St.
East St. Louis, Ill.

CAMDEN A. COBERLY, Treas.
Mallinckrodt Chemical Works
316 Oak Manor Lane
Webster Groves, Mo.

Southwestern Ohio Section

ROY O. McDUFFIE, Chairman
Dept. Chem. & Met. Eng.
University of Cincinnati
Cincinnati 21, Ohio

ARTHUR D. CASTER, Vice-Chair.
Engineering Dept.,
City of Cincinnati
City Hall,
Cincinnati 2, Ohio

LEWIS M. LEDERER, Sec.
Inner-Tank Lining Corp.
1097 Wade St.
Cincinnati, Ohio

SOUTH EAST REGION

E. D. McCAULEY, Director
American Cast Iron Pipe Co.
2030 North 16th St.
Birmingham, Ala.

R. A. DAVIS, Chairman
Chicago Bridge & Iron Co.
1500 North 50th St.
Birmingham 1, Ala.

JOHN B. WEST, Vice-Chair.
Aluminum Co. of America
1818 Rhodes—Haverty Bldg.
Atlanta, Ga.

H. C. VAN NOUHUYS, Sec.-Treas.
Southeastern Pipe Line Co.
718 Forsyth Bldg.
Atlanta, Ga.

Directory of NACE Regional and Sectional Officers

SOUTH CENTRAL REGION

T. F. P. KELLY, Director
James E. Mavor Co.
514 M & M Bldg.
Houston 2, Texas

M. C. FLEMING, Chairman
Phillips Petroleum Co.
Bartlesville, Okla.

H. E. WALDRIP, Vice-Chair.
Gulf Oil Corp.
5311 Kirby Drive
Houston, Texas

T. S. MOFFATT, JR., Sec.-Treas.
Columbia-Southern Chemical Corp.
Lawrence Drive
Corpus Christi, Texas

Central Oklahoma Section

F. W. FULLERTON, Chairman
S. W. Bell Telephone Co.
405 N. Broadway
Oklahoma City, Okla.

JOHN E. JOHNSTON, Vice-Chair.
Oklahoma Natural Gas Co.
P. O. Box 1620
Oklahoma City, Okla.

BRUCE D. OWEN, Sec.-Treas.
S. W. Bell Telephone Co.
405 N. Broadway
Oklahoma City, Okla.

W. H. MEIGS, Sec.-Trustee
Phillips Petroleum Co.
2752 N. W. 21st St.
Oklahoma City 7, Okla.

Corpus Christi Section

JOHN W. NEE, Chair.
c/o Briner Paint Mfg. Co., Inc.
3713 Agnes St.
Corpus Christi, Texas

CHARLES F. WARD, Vice-Chair.
Magnolia Petroleum Co.
Refining Dept.
Box 1179
Corpus Christi, Texas

MAURICE N. EMERY, Sec.-Treas.
Western Natural Gas Co.
Box 4218, West End Station
Corpus Christi, Texas

Houston Section

CHARLES G. GRIBBLE, JR., Chair.
Metal Goods Corp.
Box 1452
Houston, Texas

L. G. SHARPE, Vice-Chair.
Humble Pipe Line Co.
P. O. Drawer 2220
Houston 1, Texas

G. L. DOREMUS, Sec.-Treas.
Cathodic Protection Service
4601 Stanford St.
Houston, Texas

New Orleans-Baton Rouge Section

PHILIP B. WOGAN, Chair.
Products-Research-Service, Inc.
521 Ave. F.
Westwego, La.

JACK T. MARTIN, Vice-Chair.
The Texas Company
Production Dept.
P. O. Box 252
New Orleans, La.

FRANK S. BIRD, Sec.-Treas.
The California Co.
800 The California Co. Bldg.
1111 Tulane Ave.
New Orleans 12, La.

RICHARD E. MITCHELL, Asst. Sec.-Treas.
Shell Oil Co.
P. O. Box 193
New Orleans, La.

North Texas Section

H. L. BILHARTZ, Chairman
Atlantic Refining Co.
Box 2819
Dallas, Texas

J. C. SPALDING, JR., Vice-Chair.
Sun Oil Company
Box 2880
Dallas, Texas

N. P. CHESNUTT, Sec.-Treas.
Southern Union Gas Co.
1104 Burt Bldg.
Dallas 1, Texas

Permian Basin Section

JOHNNY H. SHELTON, Chair.
National Tank Co.
P. O. Box 665
Midland, Texas

LAMAR F. SUDDUTH, 1st Vice-Chair.
Stanolind Oil & Gas Co.
300 W. Illinois St.
Midland, Texas

JAY D. STAFFORD, 2nd Vice-Chair.
National Tank Co.
P. O. Box 665
Midland, Texas

WILLIAM A. HOPWOOD, Sec.-Treas.
Tnemec Company, Inc.
2718 Walnut Ave.
Odessa, Texas

Sabine-Neches Section

CHRISTOPHER A. MURRAY, Chair.
Pure Oil Company
Box 237
Nederland, Texas

CHARLES A. RIDENOUR, Vice-Chair.
Magnolia Petroleum Co.
P. O. Box 3311
Beaumont, Texas

V. M. BROWN, Sec.-Treas.
Columbia-Southern Chem. Co.
627½ Cleveland
Lake Charles, La.

Shreveport Section

TOM L. HOLCOMBE, Chairman
Holcombe & Stearns, Inc.
P. O. Box 1306
Shreveport, La.

MARION J. OLIVE, Vice-Chair.
Arkansas Natural Companies
General Engineering Dept.
Shreveport, La.

WM. F. LEVERT, Sec.
United Gas Pipe Line Co.
P. O. Box 1407
Shreveport 92, La.

JAMES M. SMITH, Treas.
Interstate Oil Pipe Line Co.
Box 1107
Shreveport 83, La.

Teche Section

CORDELL L. GARNER, Chair.
P. O. Box 85
Broussard, La.

GUS VOGLER, Vice-Chair.
Brance-Krachy Co., Inc.
P. O. Box 264
Lafayette, La.

RUSSELL W. SCHUTT, Secretary
Shell Oil Company
Box 595
Franklin, La.

Tulsa Section

J. N. HUNTER, JR., Chair.
Service Pipe Line Co.
P. O. Box 1979
Tulsa, Okla.

JACK P. BARRETT, Vice-Chair.
Stanolind Oil & Gas Co.
1136 N. Lewis St.
Tulsa, Okla.

ERNEST J. LIGGETT, Sec.-Treas.
Johns-Manville Sales Corp.
1701 East 7th St.
Tulsa 1, Okla.

WESTERN REGION

L. L. WHITENECK, Director
Long Beach Harbor Dept.
1333 El Embarcadero
Long Beach 2, Calif.

W. M. SCHILLING, Chair.
Southern Counties Gas Co.
4818 Beck Ave.
Bell, Calif.

E. H. GRIZZARD, Vice-Chair.
Signal Oil & Gas Co.
811 West 7th St.
Los Angeles, Calif.

MISS FLORA LOMBARDO, Sec.-Treas.
Amercoat Corp.
4809 Firestone Blvd.
South Gate, Calif.

Los Angeles Section

K. T. VANGSNES, Chair.
The Vanode Co.
117 E. Colorado Blvd.
Pasadena, Calif.

S. J. ARTESE, Vice-Chair.
Shell Oil Company
Box 728
Wilmington, Calif.

S. K. GALLY, Sec.-Treas.
Southern California Gas Co.
1061 Mar Vista Ave.
Pasadena 6, Calif.

Salt Lake Section

HARRY R. BROUGH, Chairman
Mountain Fuel Supply Co.
36 South State St.
Salt Lake City, Utah

GEORGE R. HILL, Vice-Chair.
Fuel Technology Dept.
University of Utah
Salt Lake City, Utah

JOHN W. COX, Sec.-Treas.
Utah Oil Refining Co.
P. O. Box 898
Salt Lake City 10, Utah

San Francisco Bay Area Section

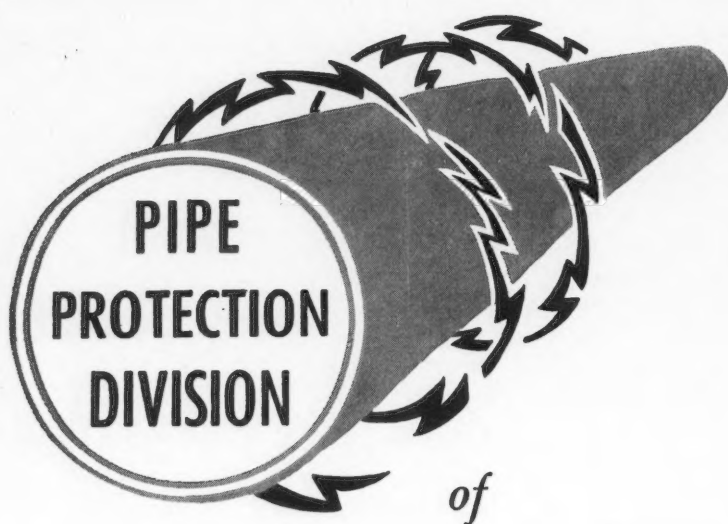
RICHARD S. TRESEDER, Chair.
Shell Development Co.
4560 Horton St.
Emeryville, Calif.

GEORGE A. WORKS, JR., Vice-Chair.
Union Oil Company
Oleum, Calif.

T. J. SMITH, Sec.-Treas.
Electric Steel Foundry
249 First St.
San Francisco, Cal.

PAPERS SOLICITED for NACE 1953 CONFERENCE

- Authors of technical papers on corrosion are invited to submit titles and abstracts of papers to appropriate officials of the Technical Program for the 1953 Chicago Conference of the National Association of Corrosion Engineers, to be held March 16-20.
- Information on symposia titles and the names of symposia chairmen named to date will be found in the News Section of the August issue of Corrosion.
- The Association also welcomes at any time constructive discussions of its technical material and technical papers on corrosion for publication in Corrosion.
- Interested authors may secure on request a copy of the "NACE Guide for the Preparation and Presentation of Papers" which describes the Association's customs and needs more fully.



ELECTRO RUST-PROOFING CORP. (N. J.)

Successful cathodic protection of cross country pipelines and gas distribution systems depends on a *thorough* analysis of each problem by competent technicians, followed by design and installation specifically applied to *your* individual needs.

ERP's Pipe Protection Division brings you the knowledge, training and dependability of highly skilled engineers and well-equipped crews backed by over 15 years of experience in all sections of the country. If you want *complete protection* of your pipe line or buried steel structure at lowest cost, write or call the *Pipe Protection Division*, ELECTRO RUST-PROOFING CORP. (N. J.), Belleville, N. J.

NEW from Johns-Manville

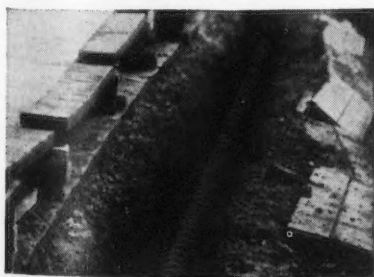
TRANTEX *polyvinyl* TAPE



... a cold applied wrap that protects underground and overhead oil and gas lines from corrosion



TRANTEX® TAPE simplifies coating of welded joints of mill-wrapped pipe—shields the pipe against corroding agents.



This pipeline needed protection without disrupting service. TRANTEX TAPE did the job. No heated kettles required... labor costs kept low.

FOR more than fifty years Johns-Manville has been manufacturing pipeline protection material. This experience, plus the knowledge gained in the research laboratory and in the field about the effects of corrosion, have gone into the making of "TranTex"—a new plastic tape for extending the service life of oil and gas lines.

TranTex needs no special equipment in its application. It is easily applied by hand or hand-operated devices. A pressure-sensitive adhesive forms a tight bond with the pipe—shields it against

the general corrosive conditions that cause most pipeline failures. TranTex has proved remarkably resistant to the effects of soil chemicals, acids, alkalies, alcohols, oil and grease, sunlight and aging.

Check the basic properties of TranTex in the table below—each one is extremely important in the control of corrosion.

For more detailed information about TranTex *polyvinyl* Tape, write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, 199 Bay Street, Toronto 1, Ont.

	*V-10	**V-20
Dielectric Strength	10,000 V	20,000 V
Insulation Resistance	100,000 megohms	100,000 megohms
Operating Temperature	200 F	200 F
Adhesion	30 oz per inch	20 oz per inch
Tensile Strength	30 lbs per inch	56 lbs per inch
Elongation at Break	250%	300%

"TranTex" is a black polyvinyl tape. It is available in two thicknesses—*V-10 is a 10 mil tape for general conditions, and **V-20 is a 20 mil thickness for use where a more rugged coating is specified.



Johns-Manville TRANTEX[®] *polyvinyl* TAPE

PROTECTS PIPELINES AGAINST CORROSION

DIRECTORY OF TECHNICAL PRACTICES COMMITTEES



TED S. ZAJAC, Chairman
Shell Oil Company,
50 West 50th St.,
New York, N. Y.

EX-OFFICIO MEMBERS

MARS G. FONTANA
WALTER F. ROGERS
A. B. CAMPBELL

(Chairmen of all TP sub-committees listed below are members of the full committee)

TP-1 CORROSION OF OIL AND GAS WELL EQUIPMENT (Formerly Condensate Well Corrosion)

H. L. BILHARTZ, Chairman
Atlantic Refining Co.
Box 2819
Dallas, Texas

R. C. BUCHAN, Vice-Chairman
Humble Oil & Ref. Co.
Box 2180
Houston, Texas

TP-1A Pacific Coast. A. H. Tomkins, Jr., Chairman. Chanslor-Cantfield Midway Oil Co., 4549 Produce Plaza, Los Angeles 58, Cal.

TP-1B Condensate Well Corrosion. R. C. Buchan, Chairman. Humble Oil & Refining Co., Houston, Texas.

TP-1C Sweet Oil Well Corrosion. H. L. Bilhartz, Chairman. Atlantic Refining Co., Dallas, Texas.

TP-1D Sour Oil Well Corrosion. Co-chairmen: J. A. Caldwell, Humble Oil & Ref. Co., Box 2180, Houston, Texas, and R. L. Elkins, Shell Oil Corp., Box 1509, Midland, Texas.

TP-1F Metallurgy—Oil and Gas Well Equipment. Co-chairmen: V. V. Kendall, National Tube Co., Box 266, Pittsburgh, Pa., and F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.

TP-1G Sulfide Stress Corrosion. R. S. Truesder, Shell Development Co., Emeryville, Cal.

TP-1H Corrosion of Oil String Casing. Jack L. Battle, Humble Oil & Ref. Co., Box 2180, Houston, Texas

TP-2 GALVANIC ANODES FOR CATHODIC PROTECTION

WALTER P. NOSER, Chairman
Humble Pipe Line Co., Drawer 2220
Houston, Texas

H. A. ROBINSON, Vice-Chairman
The Dow Chemical Co.
616 East Grove St.
Midland, Mich.

TP-2A Correlation of Data From Operating Installations. L. R. Sheppard, Shell Pipe Line Corp., Houston, Texas.

TP-3 ANODES FOR USE WITH IMPRESSED CURRENTS

DONALD H. BOND, Chairman
The Texas Pipe Line Company
P. O. Box 2332, Houston 1, Texas

A. W. PEABODY, Vice-Chairman
263 Houston Ave.
Jackson 9, Miss.

TP-4 MINIMUM CURRENT REQUIREMENTS FOR CATHODIC PROTECTION

J. M. PEARSON, Chairman
Sun Oil Co.
Bishop Hollow Road
Newtown Square, Pa.

TP-5 CORROSION PROBLEMS INVOLVED IN PROCESSING AND HANDLING CHEMICALS

MARS G. FONTANA, Chairman
The Ohio State University
Columbus 10, Ohio

PAUL J. GEGNER, Vice-Chairman
Columbia-Southern Chemical Corp.
Barberton, Ohio

TP-5A Materials and Handling and Manufacturing Sulfuric Acid. C. L. Bulow, Chairman, Bridgeport Brass Co., 30 Grand St., Bridgeport, Conn.

TP-5B Design of Equipment for Corrosive Services. W. W. Sweet, Materials of Engineering Div., Colgate-Palmolive-Peet Co., 105 Hudson Co., Jersey City 2, N. J.

TP-5C Subsurface Corrosion by Alkaline Solutions. C. F. Pogacar, Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa.

TP-5D Corrosion by Organic Acids and Bases. F. L. Whitney, Monsanto Chemical Co., 1700 S. Second St., St. Louis, Mo.

TP-5E Gasket Materials for Corrosion Service. L. D. Cook, Chairman, Wyandotte Chemical Corp., Wyandotte, Mich.

TP-6 PROTECTIVE COATINGS

KENNETH TATOR, Chairman
Consulting Engineer, Montour St.
Extension, Coraopolis, Pa.

L. L. WHITENECK, Coordinator
West Coast Division
Board of Harbor Com.
Long Beach, Cal.

TP-6A Organic Coatings and Linings for Resistance to Chemical Corrosion. Kenneth Tator, Chairman.

TP-6B Protective Coatings for Resistance to Atmospheric Corrosion. G. G. Sward, Chairman. National Paint, Varnish & Lacquer Ass'n, 1500 Rhode Island Ave., N.W., Washington, D. C.

TP-6C Protective Coatings for Resistance to Marine Corrosion. Raymond P. Devaluy, Chairman. C. A. Woolsey Paint & Color Co., 229 E. 42nd St., New York 17, N. Y.

TP-6D Pipe Line Coatings. (Chairman not appointed).

TP-6E Protective Coatings in Petroleum Production. Jack P. Barrett, Stanolind Oil and Gas Company, Tulsa, Okla.

TP-6F Protective Coatings in the Food Industry. G. W. Seagren, Chairman. The Mellon Institute, Pittsburgh, Pa.

TP-6G Surface Preparation for Organic Coatings. A. J. Liebman, Chairman. Dravo Corp., Dravo Building, Pittsburgh 22, Pa.

TP-6H Glass Linings and Vitreous Enamel. G. H. McIntyre, Chairman. Ferro-Enamel Corp., Harvard & 56th St., Cleveland 5, Ohio.

TP-6I Metallic Coatings. (Chairman not appointed).

TP-6J Standards. G. G. Sward, Chairman.

TP-6K Corrosion Resistant Construction with Masonry and Allied Materials. Robert R. Pierce, Chairman. Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia, Pa.

TP-7 MATERIALS FOR USE AT HIGH TEMPERATURES

M. A. SCHEIL, Chairman
Director Metallurgical Research
A. O. Smith, Corporation
Milwaukee, Wisconsin

TP-8 CORROSION BY WATERS

V. V. KENDALL, Chairman
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-9 CORROSION INHIBITORS

FRANKLIN M. WATKINS, Chair.
Sinclair Research Laboratories, Inc.
400 E. Sibley, Blvd.
Harvey, Illinois

ROBERT S. WISE, Vice-Chair.
National Aluminate Corp.
6216 West 66th Pl.
Chicago, Ill.

TP-10 CORROSION FATIGUE

V. V. KENDALL, Chairman
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-11 IDENTIFICATION OF CORROSION PRODUCTS

C. E. IMHOFF, Chairman
Research Supervisor, Chemical Lab.
Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.

TP-12 EFFECT OF ELECTRICAL GROUNDING ON CORROSION

GLEN APPLEMAN, Chairman
Pennsylvania Power & Light
Ninth & Hamilton St.
Allentown, Pa.

TP-13 ANNUAL LOSSES DUE TO CORROSION

F. N. ALQUIST, Chairman
The Dow Chemical Co.
Midland, Michigan

TP-14 INSTRUMENTS FOR CORROSION MEASUREMENTS

H. N. HAYWARD, Chairman
Engineering Experiment Station
University of Illinois
Urbana, Ill.

TP-15 CORROSION CONTROL IN THE TRANSPORTATION INDUSTRIES

K. K. KESSLER, Chairman
Baltimore & Ohio Railroad
Baltimore 23, Maryland

TP-16 ELECTROLYSIS AND CORROSION OF CABLE SHEATHS

IRWIN C. DIETZE, Chairman.
Dept. of Water & Power,
City of Los Angeles, Cal.

TP-16A Stray Railway Current Electrolysis. M. D. Fletcher, Chairman, Illinois Bell Telephone Co., 212 West Randolph St., Chicago 6, Ill. J. Svetlik, Co-chairman, Northern Indiana Public Service Co., 5265 Hohman Ave. Hammond, Ind.

TP-16B Corrosion of Lead and Other Metallic Sheaths. B. B. Reinitz, Chairman, The Okonite-Collender Cable Co., Inc., 730 Twenty-first St., Paterson, N. J. T. J. Maitland, Co-chairman, American Telephone & Telegraph Co., 32 Sixth Ave., New York 13, N. Y.

TP-16C Cathodic Protection of Cable Sheaths. R. H. Lawall, chairman, American Telephone & Telegraph Co., 1538 Union Commerce Bldg., Cleveland 14, Ohio. W. J. Schreiner, co-chairman, Cincinnati Gas & Electric Co., Cincinnati 2, Ohio.

TP-16D Tests and Surveys. L. J. Gorman, Chairman, Robin Beach Engineers Associated, 32 Court St., Brooklyn 2, N. Y. Frank E. Kulman, Co-chairman, Consolidated Edison Co. of New York, 4 Irving Place, New York 3, N. Y.

TECHNICAL PRACTICES COMMITTEES' DIRECTORY

(Continued from Page viii)

TP-16E *Corrosion and Protection of Pipe-Type Cables.* Frank Kahn, Chairman, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.

TP-16F *Nonmetallic Sheath Coatings.* Geo. H. Hunt, Chairman, Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.

TP-17 **STANDARDIZATION OF PROCEDURES FOR MEASURING PIPE COATING CONDUCTANCE**

W. E. HUDDLESTON, Chairman
Huddleston Engineering Co.
Bartlesville, Okla.

TP-18 **INTERNAL CORROSION OF FACILITIES FOR STORAGE AND TRANSPORTATION OF PETROLEUM**

L. G. SHARPE, Chairman
Humble Pipe Line Co.
Houston, Texas

TP-18A *Internal Sour Crude Corrosion of Pipe Lines and Tanks.* R. L. Bullock, Chairman, Interstate Oil Pipe Line Co., Box 1107, Shreveport, La.

TP-18B *Internal Corrosion of Products Pipe Lines.* Ivy M. Parker, Chairman, Plantation Pipe Line Co., Box 423, Bremen, Ga.

TP-19 **CORROSION BY DE-ICING SALTS**

F. E. KULMAN, Chairman
Consolidated Edison Company of N. Y., Inc.
4 Irving Place
New York City

Announcing

WE CAN NOW SERVE
YOU WITH

PITT CHEM

100 SERIES

Cold Applied

TAR BASE COATINGS

Perfect Protection and Corrosion
Prevention for Industrial Equip-
ment and Structures.

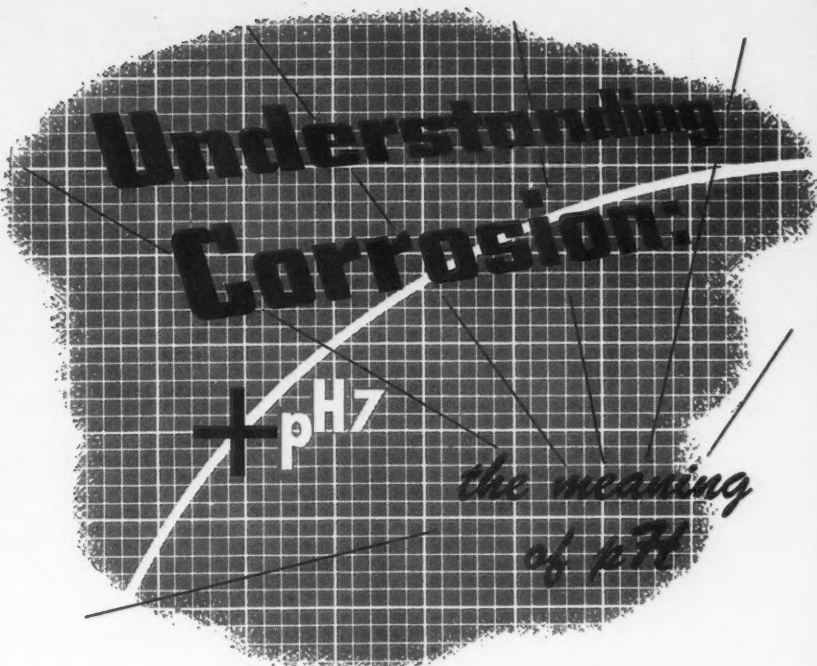
- For use on metal, brick, stone, concrete
- Withstand severest conditions and weathering
- Reduces maintenance cost—maximum protection
- Easy to apply—economical

Available from Houston Warehouse
Stock

Write—Wire—Phone
DISTRIBUTOR

S. D. DAY COMPANY

1773 WEST GRAY HOUSTON, TEXAS PHONE JU-2421



A governing factor in establishing the rate and extent of corrosive attack of a solution on metal is the determinant of acidity or alkalinity — hydrogen-ion activity. This factor is identified by the symbol pH and measured on a scale on which readings of less than pH 7 indicate acidity and more than pH 7, alkalinity. Intensity either of acidity or alkalinity exerts a primary influence on the tendency toward corrosion, with severity of corrosive attack at its greatest in the acid zone and generally decreasing as alkalinity increases. Variations in pH further alter the degree of influence of other factors in corrosion. The nature of corrosion products, for example, may be affected, thus changing the character of the resulting protective film and rendering such a film formed in the neutral or alkaline zone more effective than one formed in the acid zone.

Consideration of pH as it affects and is affected by other determining factors is essential to proper evaluation of any corrosion problem. Understanding and assessing the relative importance of this and of all factors involved is Dampney's first approach to a preventive or corrective program — an approach that forecasts with exceptional accuracy the ultimate success of the coating system selected.

In the production of chemicals, food, petroleum, textiles — wherever power and processing needs create difficult or unusual corrosion problems — you will find Dampney *equipment-engineered* coatings performing most satisfactorily. Whether your corrosion problem involves diesel engines or fume-carrying ducts . . . steam turbines or corrosive-handling tanks . . . Dampney knowledge and experience can help you. We invite you to call upon it freely.

**MAINTENANCE
FOR METAL**



**THE
DAMPNEY
COMPANY**

154-1 **HYDE PARK, BOSTON 36, MASSACHUSETTS**

SOMASTIC[★] PERMANENCE

includes TIME TESTED METHODS of Application

For the past 20 years SOMASTIC PIPE COATING has been applied to pipe by standard practices which only now are being adopted generally by the pipe coating industry. Time has proved them most effective. These methods are—

- ★ *Thorough cleaning of metal by grit-blasting.*
- ★ *Pre-heating, followed by hot priming, assuring a firm, lasting bond of coating to steel.*
- ★ *Selection of materials and manufacture of coating to rigid specifications.*

In addition, SOMASTIC leads in this essential feature—

- ★ *Application of coating to primed pipe in a continuous process by special SOMASTIC equipment to form a dense, compact, uniform and seamless protective coating of great durability.*

The general swing to methods pioneered by SOMASTIC Pipe Coating is another acknowledgment of a fact first shown by the API-Bureau Of Standards Ten Year Pipe Coating Tests . . . and since proved at thousands of corrosive locations . . . for permanence coat with SOMASTIC.

SOMASTIC

*Reg. U. S. Patent Office

PIPE COATING

Unequaled for PERMANENT PROTECTION
SOMASTIC **IS** The Best PIPE COATING

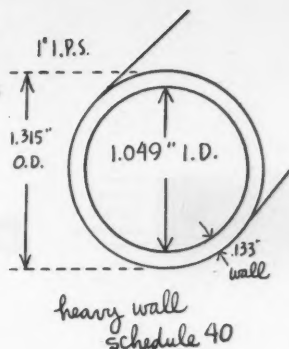
MANUFACTURED BY

H. C. PRICE CO.
BARTLESVILLE, OKLAHOMA
PHILADELPHIA, PA. • NEW ORLEANS, LA.
In the 37 States East of the Rocky Mountains

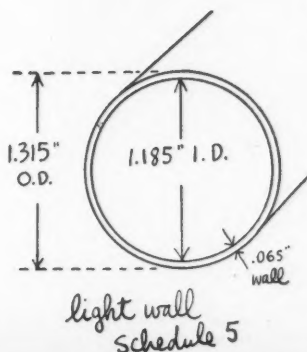
BECHTEL CORPORATION
SAN FRANCISCO and WILMINGTON
CALIFORNIA
In the 11 Western States and in Foreign Countries



Back in the days
when iron pipe was
virtually the only kind
available, it was necessary
to specify this



But today with the high
strength/weight ratio of
stainless steel, the great
majority of pipeline and
process applications will
have an ample margin of
safety with this



Why pay for Schedule 40 pipe where Schedule 5 is more than adequate?

All sizes of Carpenter Schedule 5 pipe will easily handle 150 psi working pressures. Sizes under 1½" will safely handle considerably higher pressures.

By specifying this light wall stainless pipe you gain many advantages:

1. You save money. Schedule 5 pipe costs about half as much per foot as Schedule 40.
2. Schedule 5 has the same O.D. as Schedules 10, 40 and 80—for hook-up with existing lines as well as for new installations.
3. Its larger I.D. increases flow and capacity in pipelines, exchangers and other equipment.
4. It's lighter. This means quicker and easier installation.

5. You can save 10% to 25% on valves, fittings, weld rods, etc., because smaller O.D. material can frequently be used.

6. Fittings are available from several manufacturers . . . and stocks of Schedule 5 pipe are carried by conveniently located Carpenter distributors.

7. Tubing sizes can now be replaced with light wall pipe . . . for ready hook-up with standard valves, pumps, etc.

Light wall Schedule 5 pipe saves dollars—and makes a lot of sense!

For complete data on Carpenter Schedule 5 Stainless Pipe, call your nearest Carpenter distributor or write us direct. We'll be glad to send you the information you need. **THE CARPENTER STEEL COMPANY, Alloy Tube Division, Union, N. J.**

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Carpenter
STAINLESS TUBING & PIPE



- guaranteed on every shipment

metallizing

**cuts tank maintenance
... extends life**

**pure zinc coatings
used on both
fresh and salt water types**

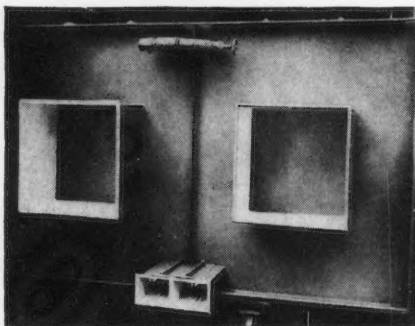


Boiler feed water tank shown encrusted with rust and mineral deposits before metallizing.



Feed water tank being metallized after preparation by grit blasting.

Tuna clipper bait tank protected with Metco System #107. Normally necessary to scale and repaint every six months. Metallized tanks in service over four years without further maintenance.



The Metco® Systems. These Systems are a series of 18 basic engineering specifications developed over 19 years of experience with pure zinc and aluminum coatings on many different types of structures and equipment. The Metco Systems provide the answer to standardization of surface preparation, metal coating thicknesses and organic after-coatings for various service conditions and appearance requirements.

Salt water bait tanks

The tank type shown here is used on west coast tuna clippers for salt water storage of live bait. Tank interiors are painted white to prevent the bait from killing themselves against the bulkheads. With paint alone, it is necessary to scale and repaint these tanks every six months. Tanks metallized in accordance with Metco System #107, which provides the desired white surface over .006" metallized zinc, have already been in service over 4 years without any further maintenance. (Photo courtesy Clark Metallizing Co.)

Here are 10 Metco System contractors

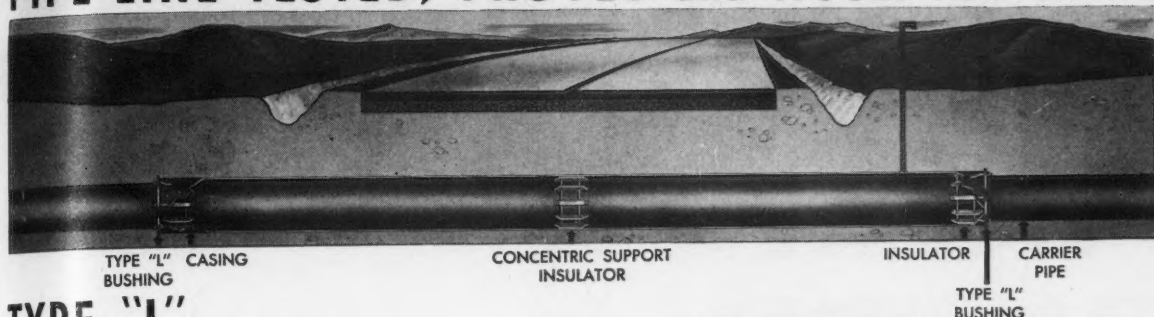
The following organizations are set up to provide positive corrosion protection at lower annual cost in accordance with Metco System specifications. For further information, or copy of descriptive bulletin, contact the one nearest you.

* Reg. U. S. Pat. Off.—Property of Metallizing Engineering Co., Inc.

Metco System contractors

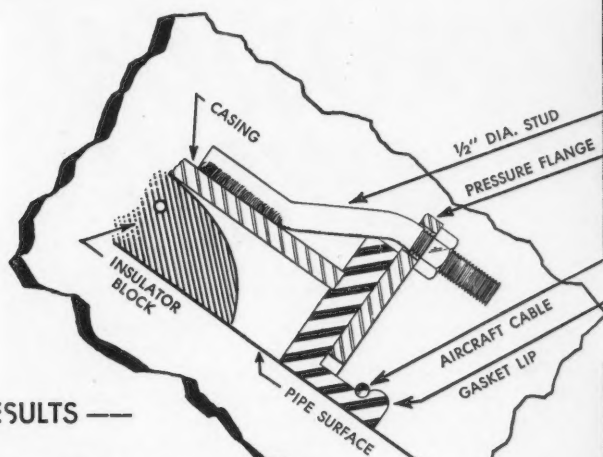
Baltimore 30, Maryland THE SOUTHERN GALVANIZING COMPANY 1616 Bush Street Tel. Gilmore 7711	New Orleans 13, Louisiana GULF ENGINEERING CO., INC. 1000 South Peters Street Tel. Canal 4421	Newport Beach, California CLARK METALLIZING, INC. 506—30th Street Tel. Harbor 2509	Barberton, Ohio AKRON SAND BLAST CO. 50 E. Springfield Rd. Tel. Plaza 3412	Buffalo 1, N. Y. METAL-CLADDING, INC. Lakeview & Porter Avenues Tel. Elmwood 9536
Lincoln Pk. 25 (Detroit), Mich. DIX ENGINEERING CO., INC. 1417 Dix Road Tel. Dunkirk 1-8822	Philadelphia 29, Pa. METALWELD, INC. Fox & Hunting Park Ave. Tel. Radcliff 5-3471	St. Louis 10, Missouri ST. LOUIS METALLIZING COMPANY 625 South Sarah Street Tel. Newstead 5253	Brooklyn, N. Y. ARTHUR TICKLE ENGINEERING WORKS, INC. 21 Delevan Street Tel. Main 5-4200	Houston, Texas F. W. GARTNER CO. 3805 Lamar Avenue Tel. Atwood 5338

PIPE-LINE TESTED, PROVED and ACCEPTED in '51



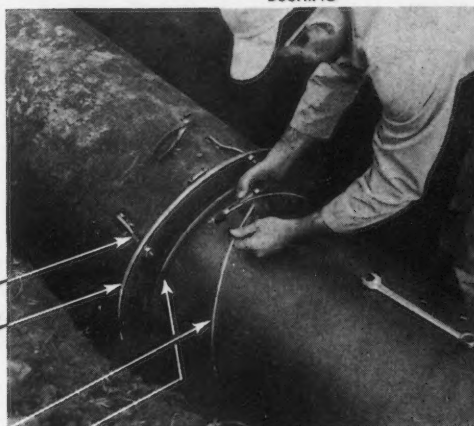
TYPE "L" WmSEAL CASING BUSHING*

A New Design: It BUTTS Against End of Casing Instead of Fitting Inside the Casing.

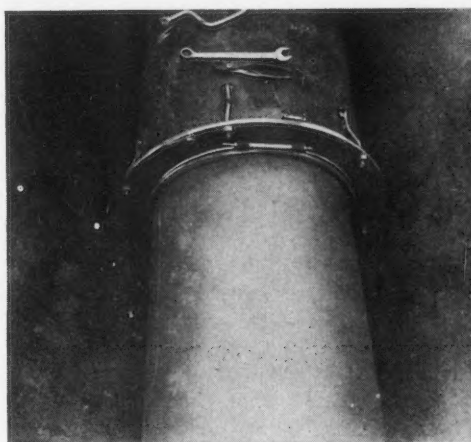


RESULTS —

1. Easier to Install CORRECTLY under worst conditions of • Out-Of-Round Casing • Narrow Space Between Pipe & Casing • Wide Variations in Casing Wall and Coating Thickness • Mud • Casing ends beveled — by machine or hand torch.
2. WATER-TIGHT Seal with "L" gasket
 - BUTTED AGAINST CASING as pressure flange is tightened on 1/2" studs welded to casing.
 - TIGHT TO THE PIPE as aircraft cable (4,600# tensile) is tightened to gasket lip. Union is rubber covered to INSULATE galvanized cable assembly from bare casing structure.
3. Always Insulated from the pipe line when a Concentric-Support Insulator is installed just inside casing after the "drag section" is in place.



Assembling cable with rubber-covered union for clamping gasket lip to pipe.



THE COMPLETED INSTALLATION
Note that galvanized cable and union are insulated from pressure flange and from pipe.

AS STRONG & DEPENDABLE AS THE MEN WHO INSTALL THEM
REPRESENTATIVES

Stuart Steel Protection Corp. | H. E. Davis | James S. Kone Co. | Keves Tank Co. | Keyes Tank & Supply Co. | Canadian Equipment Sales & Service Co., Ltd.
Kenilworth, N. J. | Los Angeles 15, Calif. | Amarillo, Texas | Provo, Utah | Casper, Wyoming | Edmonton, Calgary, Toronto, Canada

WRITE FOR BULLETIN 249A

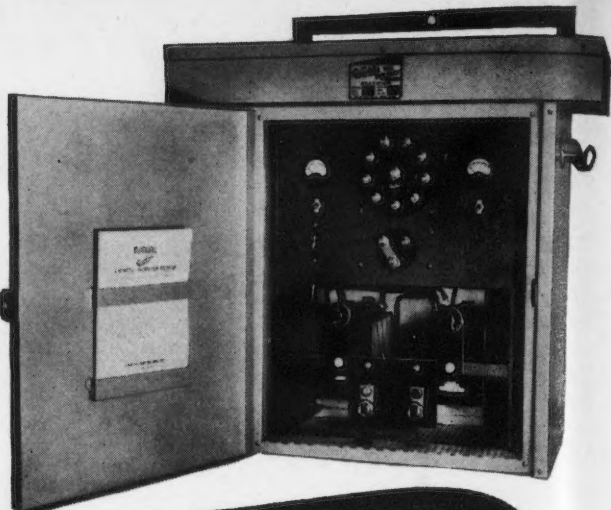
T. D. Williamson, Inc.

TULSA 9, OKLAHOMA

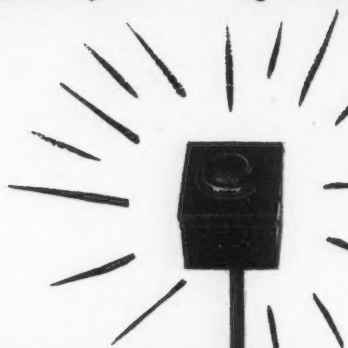
8,000 Pipe Line Casings installed in 1951 with Williamson Bushings and Insulators.



SELENIUM RECTIFIERS



KEEP CORROSION AWAY!



PERFORMANCE PROVED

Good-All Rectifiers are among the most efficient in service today! The engineering "know-how" and quality materials used in building GOOD-ALL Rectifiers is your assurance of dependable, trouble-free performance under the most severe conditions. Many units have been in operation 13 years or more and are still in A-1 condition.

IN ADDITION TO OUR STANDARD MODELS

THE NEW

ADD-A-STACK RECTIFIERS

Add One, Two, Three, total of Four Stacks.
Also models with hermetically sealed stacks.



FLASHING SIGNAL LIGHT

Now Available for Air or Auto Patrol!

- Designed to indicate failure in either A.C. or D.C. Output
- Flashing light indicates continuous cathodic protection
- Visible in Daylight 300 yards or more
- Easily installed on existing GOOD-ALL or other brands of rectifiers
- Light can be turned to face in any direction
- Order your Next GOOD-ALL Rectifier with this light.

WRITE FOR DETAILS TODAY!

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA

NEBRASKA

25 YEARS' SERVICE IN A TIDAL MARSH —no sign of corrosion!

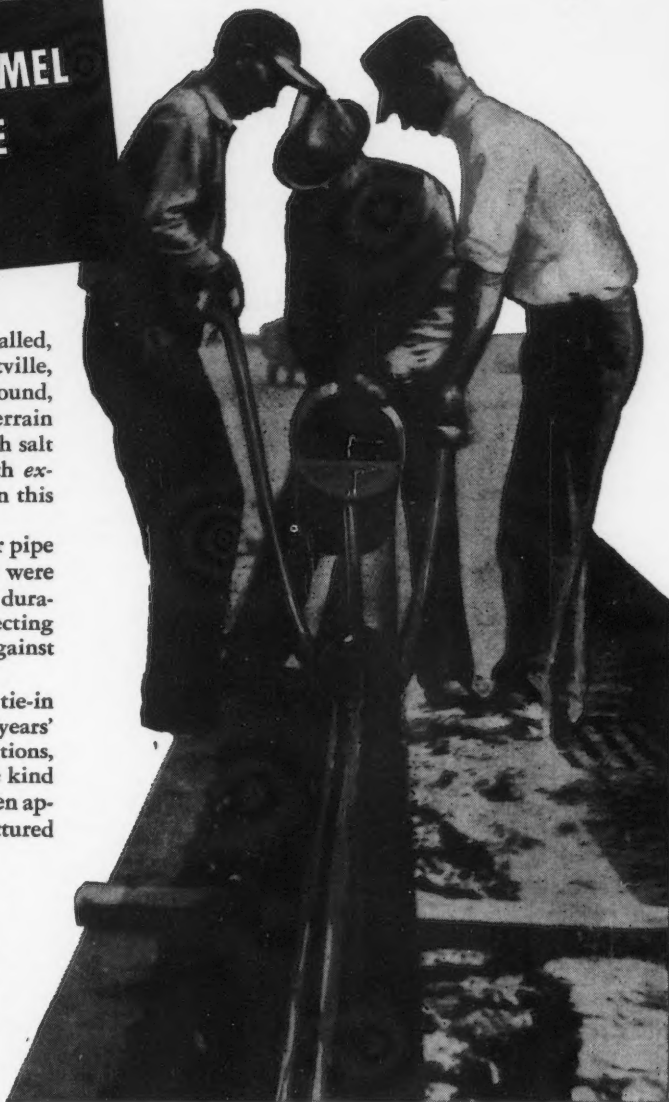
**BITUMASTIC[®] ENAMEL
PROVIDED THE
PROTECTION**

IN 1926, a 6-mile, 8-inch gas pipe line was installed, extending from Atlantic City to Pleasantville, N. J. This line was laid about two feet underground, in land known locally as "the meadows." The terrain is tidal marsh and high tides flood the land with salt water. No steel pipe line, unless provided with *exceptional* protection, could possibly last long in this corrosive soil.

The owners knew this and therefore had their pipe line protected with Bitumastic Enamel. They were influenced, to a great extent, by the fact that this durable enamel had already proved its value by protecting ships and large-diameter steel water lines against corrosion.

In 1951, a pipe section was removed so that a tie-in could be made with another pipe line. After 25 years' exposure to tidal marsh and sea-water conditions, there wasn't a sign of corrosion. This shows the kind of protection Bitumastic Enamel gives, even when applied by the old-fashioned manual method pictured here.

Today, of course, gas and oil pipe lines are cleaned, primed, coated and wrapped mechanically. Further—improvements have been made in Bitumastic Enamels in the last 25 years. Give your next pipe-line project *lasting* protection against corrosion by specifying Bitumastic Enamels. Your Koppers representative will give you complete details and estimates.



Photograph made in 1926 shows gas pipe line (Atlantic City—Pleasantville) being coated with Bitumastic Enamel. A single coat of enamel was applied by the "Sling Method" to a minimum 1/16" thickness. In 1951, a pipe section was removed so that a tie-in with another line could be made. An examination revealed no sign of corrosion.



BITUMASTIC ENAMELS
REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 904-T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS

is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

- (a) To promote the prevention of corrosion, thereby curtailing economic waste and conserving natural resources.
- (b) To provide forums and media through which experiences with corrosion and its prevention may be reported, discussed and published for the common good.
- (c) To encourage special study and research to determine the fundamental causes of corrosion, and to develop new or improved techniques for its prevention.
- (d) To correlate study and research on corrosion problems among technical associations to reduce duplication and increase efficiency.
- (e) To promote standardization of terminology, techniques, equipment and design in corrosion control.
- (f) To contribute to industrial and public safety by promoting the prevention of corrosion as a cause of accidents.
- (g) To foster cooperation between individual operators of metallic plant and structures in the joint solution of common corrosion problems.
- (h) To invite a wide diversity of membership, thereby insuring reciprocal benefits between industries and governmental groups as well as between individuals and corporations.

It is an incorporated association without capital stock, chartered under the laws of Texas. Its affairs are governed by a Board of Directors, elected by the general membership. Officers and elected directors are nominated by a nominating committee in accordance with the articles of organization. Election is by the membership.

Inquiries regarding membership, and all general correspondence should be directed to the Executive Secretary at the administrative headquarters of the National Association of Corrosion Engineers at 1061 M & M Building, No. 1 Main Street, Houston 2, Texas.



Officers, 1952-53

<i>President</i>	M. G. FONTANA
	Columbus, Ohio
<i>Vice-President</i>	WALTER F. ROGERS
	Houston, Texas
<i>Treasurer</i>	R. A. BRANNON
	Houston, Texas
<i>Executive Secretary</i>	A. B. CAMPBELL
	1061 M & M Building, Houston 2, Texas

Directors

President

M. G. FONTANA.....1952-53
Ohio State University, Columbus

Vice-President

WALTER F. ROGERS.....1952-53
Gulf Oil Corporation, Houston, Texas

Treasurer

R. A. BRANNON.....1952-53
Humble Pipe Line Company, Houston, Texas

Past President

N. E. BERRY.....1952-53
Servel Inc., Evansville, Ind.

Representing Active Membership

NORMAN HACKERMAN1952-53
University of Texas, Austin

L. A. HUGO.....1951-54
Phillips Petroleum Co., Bartlesville, Okla.

S. D. DAY.....1950-53
S. D. Day Company, Houston, Texas

AARON WACHTER1950-53
Shell Development Co., Emeryville, Cal.

Representing Corporate Membership

H. P. GODARD.....1952-53
Aluminium Laboratories, Ltd., Kingston, Ont.

V. V. KENDALL.....1952-53
United States Steel Company, Pittsburgh, Pa.

H. A. HUMBLE.....1951-54
Dow Chemical Corp., Midland, Mich.

C. P. LARRABEE.....1951-54
United States Steel Co., Vandergrift, Pa.

V. V. MALCOM.....1950-53
The Philip Carey Mfg. Co., Cincinnati, Ohio

Representing Regional Divisions

L. B. DONOVAN.....(North East) 1951-54
Consolidated Edison Co. of N. Y., New York City

FRANK L. WHITNEY, JR.. (North Central) 1950-53
Monsanto Chemical Co., St. Louis, Mo.

E. D. McCAULEY.....(South East) 1952-54
American Cast Iron Pipe Co., Birmingham, Ala.

T. F. P. KELLY.....(South Central) 1950-53
James E. Mavor Co., Houston, Texas

L. L. WHITENECK.....(Western) 1952-55
Board of Harbor Commissioners, Long Beach, Cal.

Directors Ex Officio

E. P. NOPPEL, Chairman Policy and Planning
Committee
Ebasco Services, Inc., New York, N. Y.

TED S. ZAJAC, Chairman Technical Practices
Committee
Shell Oil Corp., New York, N. Y.

R. B. HOXENG, Chairman Publication Committee
United States Steel Company, Pittsburgh, Pa.

L. A. BALDWIN, Chairman Regional Management
Committee
Johns-Manville Sales Corp., New York, N. Y.

Technical Practices Committee 1— Corrosion in Oil and Gas Well Equipment

By H. L. BILHARTZ,* Chairman

THE ACCOMPLISHMENTS of the National Association of Corrosion Engineers' Technical Practices Committee One are many and varied. Its direct contribution to the petroleum production industry can be measured in the millions of dollars. Its indirect value is immeasurable. The development of personnel, both technically and otherwise; the cooperative friendly spirit among technical men born of TP-1 participation and the reduction of tremendous operating costs that are intangible represent only a fraction of the many indirect desirable results of the NACE effort.

The writer feels so strongly of this organization that an opportunity to publicly express these sentiments in an editorial such as this is indeed welcome. It has been stated that corrosion technology has developed further in the petroleum production industry since the inception of TP-1 than in all previous time. It would be difficult to challenge this statement. A review of committee activities and reports readily document the claim. The committee is composed of accepted leaders in their field of endeavor. These men are the first to acknowledge benefits derived from active participation, both corporate-wise and personal-wise.

The TP-1 committee was established in 1944 as a condensate well corrosion committee and functioned in that capacity under the exceptionally capable leadership of Mr. W. F. Rogers. The first principal objective of the organization was to devise a suitable testing method and to test thirty-two different alloys for use in tubular goods for installation in corrosive high pressure gas condensate wells. Its mission was accomplished in a relatively short time. From this embryonic state, as observed in retrospect, the committee was expanded to include all corrosion phases of oil and gas production. Through the successive leadership of Mr. Ted Zajac and Mr. H. E. Waldrip the organization grew in strength and scope until today it constitutes a working "human machine" capable of attacking successfully the major problems

of our industry. To these leaders and to the many members who have devoted much personal time and effort to committee activities and to the NACE itself that provided the machinery for cooperative effort, the entire petroleum industry owes its thanks.

As is often the case, TP-1 projects have overlapped in scope with those of other technical and industry societies' committees. As is unfortunately *not* too often the case, in this instance every effort has and is being made to coordinate the overlapping activities. The most notable example is that found in the work of various American Petroleum Institute subcommittees. Membership of API and NACE, in general, composes two entirely different segments of personnel. Representatives of management and high forces of management most often actively engage in API activities. These are influential and brilliant men all devoted to solving problems of our industry. However, due to their wide interests, it has at times been difficult to achieve real technical success in specific problems, such as corrosion, even though these problems may be of tremendous economic importance. NACE provides a necessary cog in the machine by supplying a competent technical organization of men specifically interested in the solution of corrosion problems. The accomplishments of these technical men supplement the work of the more general API committees. To assure coordination of these two associations API is represented at TP-1 meetings and receives minutes of these meetings, and conversely TP-1 is recognized at API discussions. The value to the petroleum industry of cooperative effort such as this is readily apparent to all who have in the past participated in other organizations where a spirit of direct competition prevailed. Duplication of effort has been avoided and time often lost in non-productive argument has become almost non-existent.

The membership of TP-1 today composes representatives of some thirty major producing companies. By actively supporting this committee, these companies have found that they can solve their more general problems in a shorter period and with less expenditures of research dollars than by any other

* Atlantic Refining Co., Dallas, Texas.

approach. To date only major companies have actively participated in TP-1. This has not followed from exclusion of independent operators but is the result of independent producers not knowing about the committee. At the last meeting of TP-1 a motion was adopted to encourage active participation of smaller companies which can offer much to the committee and can receive much in return. They have always had and will continue to have access to information through regular publication of results. However, independent operators can obtain pertinent data and facts much quicker and more thoroughly through active participation. This endeavor illustrates again the desire of TP-1 to expand its scope and activity and to continue its aggressive pursuit of technical solutions to the economic betterment of the whole industry.

Technical Practices Committee TP-1 is composed of forty-four official members, yet its attendance at the last meeting in Galveston was 125 members and guests. This single fact illustrates as much as any other the interest in committee activities that has developed in the petroleum industry.

To technical members of our industry who read this article and who are not active in our work, I should like to solicit inquiries concerning your active participation. You, too, can derive benefits from the Oil and Gas Production committee of NACE.

To members of management of oil and gas producing companies, both large and small, I would solicit committee support from your company both through active company participation and through corporate membership in NACE. Financial support through corporate membership will insure continuation of this program. The budget of NACE is not large but certain minimum expenditures are necessary to conduct the business of any organization such as this. Much of the contribution of NACE TP-1 has resulted from the work of young technical men who can ill afford high active membership dues. Realizing

this, the NACE Board of Directors has made every effort to keep these dues within the reach of most junior engineers. The \$100 annual corporate membership fee is repaid in actual dollars and cents many, many times in the course of each year.

Possibly one of the most appreciated commendations to TP-1 was received recently from a member of management of one of the major companies actively supporting NACE. An excerpt from this commendation constitutes an appropriate conclusion to a report on NACE TP-1 Committee. It expresses the sentiment of many who have realized economic and personal gain from these activities. Mr. V. E. Stepp, Chief Engineer of the Atlantic Refining Company, visited a TP-1 meeting last year. Subsequent to the meeting, he submitted a letter to Mr. H. E. Waldrup, then chairman of the committee. This letter read in part as follows:

"I don't think I have ever attended a committee meeting of any sort that was as well conducted as this one. It was my purpose in attending the meeting to learn a little more about NACE and the general problems of corrosion. The proceedings were exceedingly interesting and personally helpful to me. I was much impressed with the accomplishments which this group has made and with the interest in the industry's problem of corrosion. I think we have all experienced the difficulty with superfluous discussion in committees as large as this, but this one seemed to be unique in that all discussion was helpful and pertinent to the objectives at hand."

Mr. Waldrup, in commenting on the letter at the Galveston meeting, suggested it would be very desirable if members of management of other companies could attend a TP-1 meeting to determine for themselves the earnestness with which this group attacks a problem and the accomplishments it achieves.

It behooves committee TP-1 to live up to this commendation by continuing its contribution to the petroleum industry.

The organization and membership of TP-1 and its subcommittees are given below.

TP-1 CORROSION OF OIL AND GAS WELL EQUIPMENT

CHAIRMAN: H. L. Bilhartz, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.

VICE-CHAIRMAN: R. C. Buchan, Humble Oil & Refining Co., P. O. Box 2180, Houston, Texas.

MEMBERS:

Dan H. Carpenter, Sohio Petroleum Co., 1200 Skirvin Tower, Oklahoma City, Okla.
Jack L. Battle, Humble Oil & Refining Co., Box 2180, Houston, Texas.
Frank Dial, Pure Oil Co., 239 City National Bank Bldg., Houston, Texas.
J. P. Barrett, Stanolind Oil & Gas Co., 1136 N. Lewis Street, Tulsa, Okla.
Morris Bock, Sun Oil Co., 1405 N. Zangs Blvd., Dallas, Texas.
J. A. Caldwell, Humble Oil & Refining Co., P. O. Box 2180, Houston, Texas.
W. H. Edwards, Superior Oil Company, Room 404, Oil & Gas Bldg., Houston, Texas.
C. K. Ellerts, U. S. Dept. of Interior, Bureau of Mines, Bartlesville, Okla.
R. L. Elkins, Shell Oil Co., P. O. Box 1509, Midland, Texas.
A. W. Galbraith, Babcock & Wilcox Tube Co., 207 Bankers Mortgage Bldg., Houston, Texas.
W. H. Garvin, Magnolia Petroleum Co., Box 900, Dallas, Texas.
H. E. Greenwell, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.
E. C. Greco, United Gas Pipe Line Co., P. O. Box 1407, Shreveport, La.
H. J. Haynes, The California Co., 800 The Calif. Co. Bldg., New Orleans, La.
R. L. Hock, Cotton Valley Operators, Cotton Valley, La.
M. E. Holmberg, 4101 San Jacinto, Houston, Texas.

F. A. Hunter, J. S. Abercrombie Co., Drawer C., Sweeny, Texas.

Edwin Joyce, 816 Rio Grande National Bldg., Dallas 2, Texas.

J. W. Juppenlatz, Lebanon Steel Foundry, First Ave. & Lehman St., Lebanon, Pa.

E. O. Kartinen, Signal Oil & Gas Co., 811 W. 7th St., Los Angeles, Calif.

V. V. Kendall, National Tube Co., Box 266, Pittsburgh, Pa.

H. T. Kennedy, A. & M. College of Texas, Petr. Engr. Dept., College Station, Texas.

Richard Lembcke, Cities Service Oil Corp., Tallant, Okla.

B. B. Morton, The International Nickel Co., 67 Wall St., New York, N. Y.

G. J. W. Murphy, The Texas Co., Box 425, Bellaire, Texas.

W. F. Oxford, Sun Oil Co., P. O. Box 2831, Beaumont, Texas.

F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.

R. J. Rice, The International Nickel Co., 1107 Commerce Bldg., Houston, Texas.

W. F. Rogers, Gulf Oil Corp., Drawer 2100, Houston, Texas.

J. J. B. Rutherford, The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

D. A. Shock, Continental Oil Co., Prod. Lab., P. O. Drawer 1267, Ponca City, Okla.

P. P. Spafford, Stanolind Oil & Gas Co., Box 3092, Houston, Texas.

W. H. Stewart, Sun Pipeline Co., Sun Oil Co., San Jacinto Bldg., Beaumont, Texas.

E. H. Sullivan, United Gas Pipe Line Co., P. O. Box 1407, Shreveport, La.

P. D. Thomas, Asiatic Petroleum Corp., 50 West 50th St., New York 20, N. Y.

R. S. Treseder, Shell Development Co., 4560 Horton Street, Emeryville, Calif.

L. W. Vollmer, Gulf Res. & Dev. Co., P. O. Drawer 2038, Pittsburgh 30, Pa.

J. W. Young, Imperial Oil, Ltd., 1409 Premier Way, Calgary, Alberta, Canada.

T. S. Zajac, Shell Oil Co., 50 West 50th St., New York 20, N. Y.

Mary Ann Duggan, Magnolia Petroleum Co., Box 900, Dallas, Texas.

T. E. Griffith, Tidewater Associated Oil Co., Box 1404, Houston, Texas.

R. H. McCall, The Texas Co., Box 2332, Houston, Texas.

H. W. Waldrup, Gulf Oil Corp., 5211 Kirby Drive, Houston, Texas.

W. M. Thornton, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.

SUB-COMMITTEE TP-1A CORROSION OF OIL AND GAS WELL EQUIPMENT (Pacific Coast)

CHAIRMAN: Albert H. Tompkins, Jr., Chancellor-Canfield Midway Oil Co., 4544 Producers Plaza, Los Angeles 58, Calif.

VICE-CHAIRMAN: J. J. Browne, General Petroleum Corp., P. O. Box 725, Los Angeles, Calif.

MEMBERS:

J. A. Biren, The Texas Co., P. O. Box 320, Long Beach 1, Calif.

F. D. Bradbury, Kettleman North Dome Ass'n., Bin "C", Avenal, Calif.

R. W. Clark, Jr., Richfield Oil Corp., 555 South Flower St., Los Angeles, Calif.

W. L. Crooks, Long Beach Oil Dev. Co., P. O. Box 199, Long Beach 2, Calif.

R. D. Dillard, Western Gulf Oil Co., P. O. Box 471, Bakersfield, Calif.

J. E. Gallagher, Shell Oil Co., 1008 W. 6th St., Los Angeles, Calif.

R. M. Gray, Long Beach Oil Dev. Co., 255 S. Santa Clara Ave., Long Beach 2, Calif.

P. M. Jor
Los Ang
E. O. Kar
7th St.
D. R. K
Ass'n.
J. D. Lyt
Long Be
H. J. Mat
Avenal, Ca
D. M. Mo
P. O. Bo
A. L. Mo
P. O. Bo
W. S. Ost
7th St.
J. S. Rom
Fellow
T. H. Sha
Calif.
John R.
11-C Ca
C. J. Smi
471, Bal
Randolph
Flower
E. Thyge
Dept. 2
R. J. Vill
P. O. Bo
K. C. Yea
470, Lon

SUB-COMMITTEE TP-1B CORROSION OF OIL AND GAS WELL EQUIPMENT (Gulf Coast)

CHAIRMAN: Refining

Texas.

MEMBER:

C. M. Bl

Webster

Morris Bo

Dallas,

W. H. Ed

& Gas

C. K. Ell

of Minn

E. C. Gro

Box 14

H. J. H

Calif.

R. L. Ho

Valley,

M. E. Ho

ton 4,

F. A. Hu

C. Swe

E. F. Kel

Housto

F. A. Pr

ville, C

R. J. Ric

Comm

P. P. Sp

Box 30

W. H. S

Co. S

H. E. V

Drive,

E. W.

Texas.

P. M. Jorda, Shell Oil Co., 1008 W. 6th St., Los Angeles, Calif.
 E. O. Kartinen, Signal Oil & Gas Co., 811 W. 7th St., Los Angeles, Calif.
 D. R. Knowlton, Kettleman North Dome Ass'n., Bin "C", Avenal, Calif.
 J. D. Lynch, Richfield Oil Corp., 130 Pico Long Beach, Calif.
 H. J. Matthews, Union Oil Co., 17810 Central Ave., Compton, Calif.
 D. M. McCloud, California Research Corp., P. O. Box 446, La Habra, Calif.
 A. L. Mortimer, Standard Oil Co. of Calif., P. O. Box 397, La Habra, Calif.
 W. S. Ostling, Signal Oil & Gas Co., 811 West 7th St., Los Angeles, Calif.
 J. S. Romp, The Texas Co., P. O. Box "G", Fellows, Calif.
 T. H. Shannon, Belridge Oil Co., McKittick, Calif.
 John R. Shore, Standard Oil Co. of Calif., 11-C Camp, Taft, Calif.
 C. J. Smith, Western Gulf Oil Co., P. O. Box 471, Bakersfield, Calif.
 Randolph Smith, Seaboard Oil Co., 612 South Flower St., Los Angeles 14, Calif.
 E. Thygeson, General Petroleum Corp., Dept. 2525 E. 37th St., Los Angeles, Calif.
 R. J. Villagrana, Standard Oil Co. of Calif., P. O. Box 397, La Habra, Calif.
 C. E. Yerby, Richfield Oil Corp., P. O. Box 470, Long Beach, Calif.

SUB-COMMITTEE TP-1B CONDENSATE WELL CORROSION

CHAIRMAN: R. C. Buchan, Humble Oil & Refining Co., P. O. Box 2180, Houston, Texas.

MEMBERS:

C. M. Blair, Tretolite Co., 937 Pacific Ave., Webster Groves, Mo.
 Morris Bock, Sun Oil Co., 1405 N. Zangs Blvd., Dallas, Texas.
 W. H. Edwards, Superior Oil Co., Rm. 404 Oil & Gas Bldg., Houston, Texas.
 C. K. Ellerts, U. S. Dept. of Interior, Bureau of Mines, Bartlesville, Okla.
 E. C. Greco, United Gas Pipe Line Co., P. O. Box 1407, Shreveport, La.
 H. J. Haynes, The California Co., 800 The Calif. Co. Bldg., New Orleans, La.
 R. L. Hock, Cotton Valley Operators, Cotton Valley, La.
 M. E. Holmberg, 4101 San Jacinto St., Houston 4, Texas.
 F. A. Hunter, J. S. Abercrombie Co., Drawer C, Sweeney, Texas.
 F. F. Kelly, Dowell Inc., 2115 Commerce Bldg., Houston, Texas.
 F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.
 R. J. Rice, The International Nickel Co., 1107 Commerce Bldg., Houston, Texas.
 P. P. Spafford, Stanolind Oil & Gas Co., P. O. Box 3092, Houston, Texas.
 W. H. Stewart, Sun Pipe Line Co., Sun Oil Co., San Jacinto Bldg., Beaumont, Texas.
 H. E. Waldrip, Gulf Oil Corp., 5311 Kirby Drive, Houston, Texas.
 E. W. Wallace, 5304 Huisache, Bellaire, Texas.

C. P. Seiss, Tretolite, Box 253, Monroe, Louisiana.

SUB-COMMITTEE TP-1C SWEET OIL WELL CORROSION

CHAIRMAN: H. L. Bilhartz, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.

VICE-CHAIRMAN: H. E. Greenwell, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.

MEMBERS:

R. C. Buchan, Humble Oil & Ref. Co., P. O. Box 2180, Houston, Texas.
 W. H. Edwards, Superior Oil Co., Room 404, Oil & Gas Bldg., Houston, Texas.
 H. J. Haynes, The California Co., 800 The Calif. Co. Bldg., New Orleans, La.
 W. F. Rogers, Gulf Oil Corp., Drawer 2100, Houston, Texas.
 H. E. Waldrip, Gulf Oil Corp., 5311 Kirby Drive, Houston, Texas.
 E. W. Wallace, 5304 Huisache, Bellaire, Texas.

SUB-COMMITTEE TP-1D SOUR OIL WELL CORROSION

CHAIRMAN: J. A. Caldwell, Humble Oil & Refin. Co., P. O. Box 2180, Houston, Texas.

VICE-CHAIRMAN: R. L. Elkins, Shell Oil Co., P. O. Box 1509, Midland, Texas.

MEMBERS:

J. P. Barrett, Stanolind Oil & Gas Co., 1136 N. Lewis St., Tulsa, Okla.
 J. L. Battle, Humble Oil & Refining Co., Box 2180, Houston, Texas.
 L. A. Bell, Dia-Log Co., Box 2426, Odessa, Texas.
 H. L. Bilhartz, Atlantic Refining Co., Box 2819, Dallas, Texas.
 P. P. Blanda, Kewanee Oil Co., Box 848, Crane, Texas.
 C. O. Bundrant, The Western Co., Box 310, Midland, Texas.
 Fred Converse, Stanolind Oil & Gas Co., Box 1540, Midland, Texas.
 W. H. Crenshaw, American Inspection Service, Box 789, Midland, Texas.
 F. L. Current, Oil Well Supply Co., Oil City, Pa.
 L. W. Folmar, The Texas Co., Box 1270, Midland, Texas.
 E. C. Greco, United Gas Pipe Line Co., P. O. Box 1407, Shreveport, La.
 Jack Hamilton, Gulf Oil Corp., Box 83, Crane, Texas.
 R. E. Lembcke, Cities Service Research & Dev. Co., Tallant, Okla.
 W. F. Oxford, Sun Oil Co., Box 2831, Beaumont, Texas.
 F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.
 J. C. Spalding, Jr., Sun Oil Co., Box 2880, Dallas, Texas.
 H. E. Waldrip, Gulf Oil Corp., 5311 Kirby Dr., Houston, Texas.

SUB-COMMITTEE TP-1E BI-METALLIC GALVANIC CORROSION IN OIL AND GAS WELLS. This Sub-Committee has been consolidated with TP-1F.

SUB-COMMITTEE TP-1F METALLURGY OF OIL AND GAS WELL EQUIPMENT

CHAIRMAN: F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.

MEMBERS:

C. K. Ellerts, U. S. Dept. of Interior, Bureau of Mines, Bartlesville, Okla.
 J. W. Juppenlatz, Lebanon Steel Foundry, First Ave. & Lehman St., Lebanon, Pa.
 E. F. Kindsvater, Phillips Petroleum Co., Bartlesville, Okla.
 B. B. Morton, International Nickel Co., 67 Wall St., New York, N. Y.
 L. W. Vollmer, Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pa.
 V. V. Kendall, National Tube Co., P. O. Box 266, Pittsburgh, Pa.

SUB-COMMITTEE TP-1G SULFIDE CORROSION CRACKING

CHAIRMAN: R. S. Treseder, Shell Development Co., 4560 Horton St., Emeryville, Calif.

MEMBERS:

A. C. Broyles, Carter Oil Co., Tulsa, Okla.
 V. V. Kendall, National Tube Co., Box 266, Pittsburgh, Pa.
 J. I. Morris, The Pure Oil Co., P. O. Box 700, Worland, Wyoming.
 B. B. Morton, The Intern'l Nickel Co., 67 Wall St., New York, N. Y.
 F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.
 J. J. B. Rutherford, The Babcock & Wilcox Tube Co., Beaver Falls, Pa.
 L. W. Vollmer, Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pa.
 H. E. Greenwell, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.

SUB-COMMITTEE TP-1H CORROSION OF OIL STRING CASING

CHAIRMAN: Jack L. Battle, Humble Oil & Refining Co., Box 2180, Houston, Texas.

MEMBERS:

L. C. Case, Gulf Oil Corp., Box 661, Tulsa, Okla.
 J. P. Garrett, Stanolind Oil & Gas Co., 1136 N. Lewis St., Tulsa, Okla.
 H. L. Bilhartz, Atlantic Refining Co., Box 2819, Dallas, Texas.
 Morris Bock, Sun Oil Co., 1405 N. Zangs Blvd., Dallas, Texas.
 W. H. Edwards, Superior Oil Co., Houston, Texas, Rm. 404 Oil & Gas Bldg.
 W. H. Garvin, Magnolia Petroleum Company, Box 900, Dallas, Texas.
 Richard Lembcke, Cities Service Oil Corporation, Tallant, Oklahoma.
 R. H. McCall, The Texas Company, Box 2332, Houston, Texas.
 H. C. Morgan, Gulf Oil Corporation, Houston, Texas.
 G. J. W. Murphy, The Texas Company, Box 425, Houston, Texas.
 W. F. Oxford, Sun Oil Company, Box 2831, Beaumont, Texas.
 F. A. Prange, Phillips Petroleum Co., Bartlesville, Oklahoma.
 D. A. Shock, Continental Oil Company, Drawer 1267, Ponca City, Oklahoma.
 E. H. Sullivan, United Gas Pipe Line Company, Box 1407, Shreveport, La.
 E. W. Wallace, 5304 Huisache, Bellaire, Texas.

Corrosion Control in Gas-Lift Wells*

By D. A. SHOCK and J. D. SUDBURY*

CORROSION in gas-lift wells was first noted in the authors' organization in December 1947 when a failure in the tubing occurred in a well and 132 joints were so badly pitted and generally corroded that they had to be replaced. The other wells in the field were examined, and a number of cases of corrosion were discovered. For a time it was believed that the corrosive conditions being experienced in this field were unique; however from the work in other fields in the past two years and from the preliminary data gathered by the TP-1C committee, it is obvious that one can anticipate a major corrosion problem in the older, deeper oil wells, particularly those in the Gulf Coast Region. This paper was prepared to present test methods and to discuss the factors which seem significant in predicting corrosive behavior of such wells and in establishing corrosion protection for them.

Determination of Corrosive Environment

Two facts emerged from the initial corrosion survey. The first was that the corrosion criteria which had been used in condensate wells were not directly applicable to the corrosion found in the oil wells. Thus, the coupons exposed in the surface line or Christmas trees and the iron contents of the water indicated that the well was only slightly corrosive if judged by condensate well experiences, whereas failures in the tubing and pit depths by caliper survey showed that a very corrosive condition existed. The second fact which became evident was that a very significant number of corrosion failures were taking place in the gas-lift wells.

It became obvious that the general corrosive criteria set up for condensate wells would need revision in order to be applicable to oil well systems; however the rules should be valid if the basic principles on which they were made were kept in mind. The test well data showed that the corrosive wells had a coupon corrosion rate of from one to ten mpy (milli-inches penetration per year) and the produced liquid an iron content of 25 ppm. The wellhead pressure was from 100 to 200 psi and the CO₂ content in the gas from two to four percent, depending on the ratio of produced to gas-lift gas from the well. Thus, the partial pressure of CO₂ at the wellhead was calculated to be from two to eight pounds, which is about the partial pressure range where condensate wells generally are moderately corrosive. In other words, the corrosion rate at the wellhead was in the predicted corrosive range. Acculation of the carbon

Abstract

Severe corrosion was found to be taking place in the South Texas oil wells where producing pressures were not abnormally high. Most of these wells were produced by gas lift. An investigation was instigated to study the causes of the corrosion and find some means of bringing it under control. An Otis type "F" tubing stop was developed to hold a specially designed coupon so that the corrosion rates could be checked at various levels in the tubing. The studies indicated that the rates of corrosion followed the general corrosive criteria set up for condensate wells when the pressure conditions at given depths and temperatures and CO₂ contents were considered. The top-hole coupons did not reflect the actual severity of corrosion which could be taking place down the hole in the same manner as they do in condensate wells. It was also found that in these gas-lift wells a considerable height of water column was present in the annular space, and any successful inhibition method had to be so designed that the inhibitor would mix in the water and diffuse through it to fall to the bottom. Oil soluble and emulsifiable inhibitors were therefore found to be unsatisfactory, because they were blown through the gas-lift valves and never reached the bottom of the tubing. General factors governing corrosion mitigation problems in these oil wells are discussed.

dioxide partial pressures for bottom-hole conditions, however, showed that a very severe corrosion must occur in the lower portions of the tubing. These wells are approximately 7500 feet deep and have bottom-hole pressures of about 3000 psi. The partial pressures for CO₂ at bottom-hole conditions therefore are calculated to be a minimum of 60 psi. A pressure-temperature traverse was taken for one of the wells; and from the data, the solubility curve for CO₂ was calculated for points from the top to the bottom of the well. The curves were drawn and are shown in Figure 1. These considerations demonstrate clearly that the corrosive rate for the major portion of the tubing is not reflected by the surface coupon and it

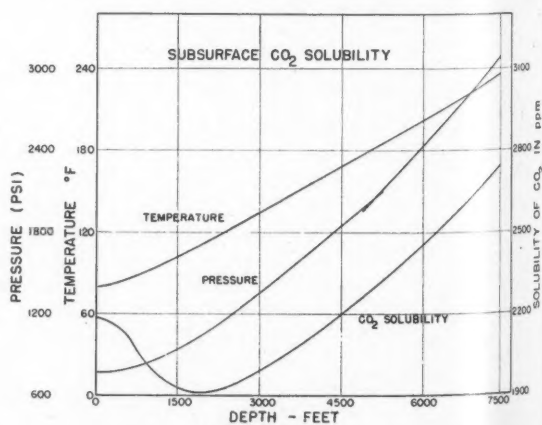


Figure 1

* A paper presented at the Eighth Annual Conference, National Association of Corrosion Engineers, Galveston, Texas, March 10-14, 1952.

* Production Research Laboratory, Continental Oil Co., Ponca City, Okla.

was concluded that a means should be devised to check subsurface rates.

The fact that most of the corrosion was found in the gas-lift wells resolved itself more specifically to the fact that corrosion occurred in wells producing appreciable amounts of water. Thus it was apparent that any well producing sufficient water which was appreciably acid would be corrosive. The relations between the amount of water produced, the oil-water ratio and the iron content of the waters in corrosive wells have not yet been fully established.

A review of the concepts of the mechanism of oil well corrosion because of hydrogen ion concentrations was made in an earlier paper, and the authors' views were presented more fully there.¹ The members of the TP-1C committee are currently endeavoring to define the conditions which make for corrosive oil wells. It is anticipated that this survey will be considerably more authoritative than one made by a single investigator. It is obvious, however, from the data at hand that the corrosion rate from a given well increases tremendously as the water-oil ratio increases, and estimates of corrosive conditions can be made on the basis of acidity of the produced water at well conditions.

Corrosion Tests Down the Hole

A type "F" Otis tubing stop was fitted with a collar adapter as shown in Figure 2 so that a corrosion coupon could be bolted to the bottom and run into the tubing on a wire line. The assembled unit is shown in Figure 3. Three such holders were prepared and run in the hole at various depths. Several dozen runs have now been made with only one mishap. This occurred when the wellhead coupon was insecurely fastened and fell on top of the coupon holder. A fishing job was required, but no damage was done to the well or equipment. Typical results are tabulated in Table I. The tests were run at three different times in the well and at various depths. The rates indicate that the corrosion taking place was some ten times as severe below the bottom gas-lift valve as it was on the surface.

Inhibition Methods

It was believed that the corrosive attack could be brought under control quite simply by injecting the proper inhibitor down the annular space. The down-hole coupon method was used in order to determine the reduction in rate at the highest and most severely corrosive zone. The results of the down-hole coupon tests soon disclosed numerous unrecognized aspects of the problem of inhibiting corrosion in oil wells and especially in gas-lift wells. Figure 4 summarizes the tests on three inhibitors of various types which illustrate quite well the difficulty encountered. In the well under discussion three gas-lift valves were set, the lowest being at 3200 feet. Coupons were set at the top and bottom of the well in all cases and for some tests just above the bottom gas-lift valve. The corrosion rates were established for three positions in the tubing before injection. The first inhibitor* was an

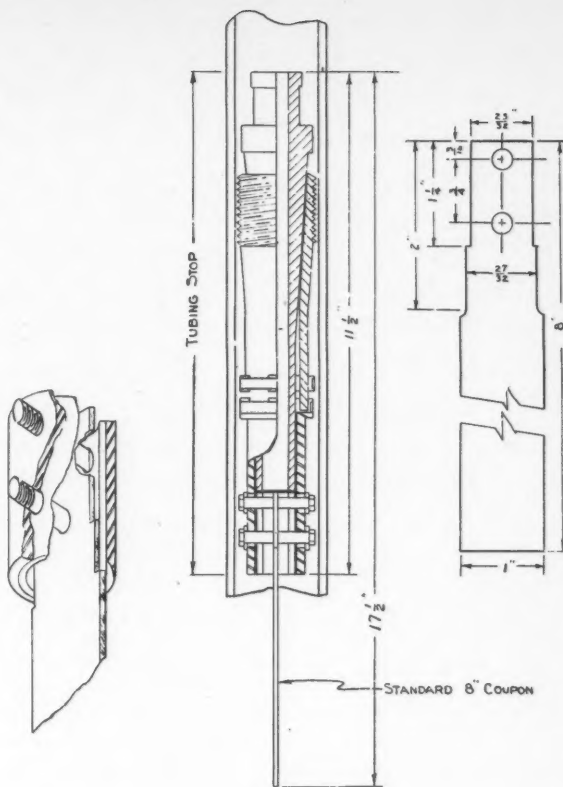


Figure 2

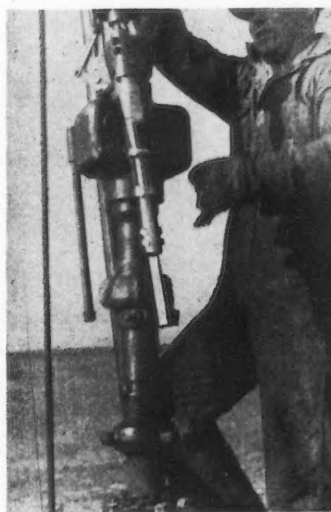


Figure 3—Coupon assembly.

TABLE I

Depth In Feet	Run I m. p. y.	Run II m. p. y.	Run III m. p. y.
Surface	5.60	3.86	7.61
2216	8.44	5.82	...
3076	33.0
4164	60.9	49.0	...
5373	65.7
7618	80.3	37.5	65.3

5 1/2 m. p. y. = millinches per year.
Note: Bottom gas lift valve at 3,200 feet.

* These are proprietary corrosion inhibitors marketed by the Tretolite Company under U. S. Patent RE 23,227.

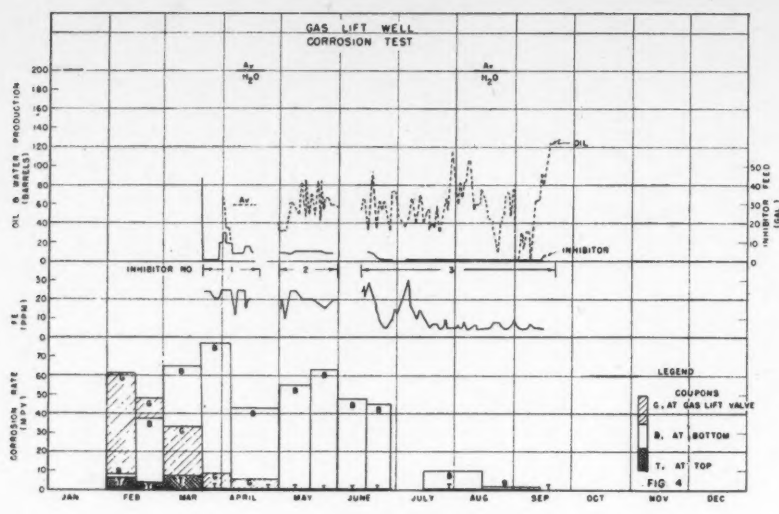


Figure 4

oil soluble polar type material described as a high molecular weight semipolar heterocyclic compound consisting largely of mixtures of substituted flyoxalidine with rather large substituted hydrocarbon radicals. Inhibition with this material brought the corrosion of the wellhead coupon to practically zero and reduced the rate on the coupon at the gas-lift valve. The second inhibitor* was very similar but contained an emulsifying agent which made it water dispersible. This was introduced as an emulsion in the produced water with approximately the same results as before. The bottom coupon showed high rates, while the top indicated protection. The iron values were about the same as previously noted. The third inhibitor was a sodium arsenite based water soluble liquid of high specific gravity. When this was introduced, the iron values declined; and the rates on the bottom coupon reached a minimum. These results clearly showed that the first two inhibitor treatments were not effective for the bottom coupons where the majority of the corrosion was taking place. The water soluble inorganic liquid inhibitor, although effective in corrosion control on this test, showed a number of disadvantages in use which precluded consideration of its further use. Echo meter tests showed that a high fluid level existed in these wells; and from calculations, it has been concluded that the fluid was mostly water. Subsequent work and inspection of the tubing as it was removed from the well clearly indicated that a water column existed at least as high as the bottom gas-lift valve while the well was operating.

In order to obtain a better physical concept of what was taking place, a model gas-lift well was constructed in the laboratory. Figure 5 shows a drawing of the model. Water and oil are let in the bottom until they rise above the gas-lift valve. The gas pressure is then turned on; and the fluid is forced down the annular space with part going through the valve into the tubing and part being forced to the

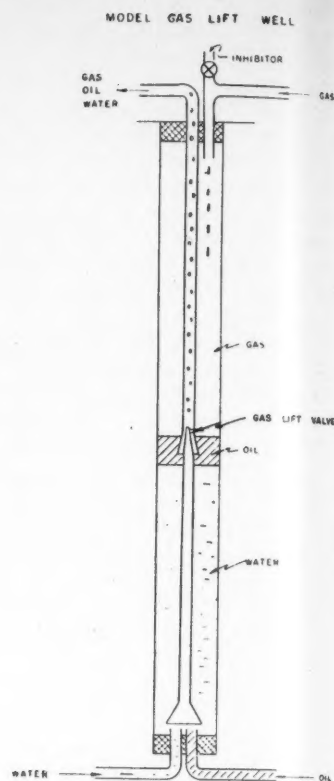


Figure 5—Model gas lift well.

bottom and into the tubing. When the liquid level reaches the valve level, gas lifting takes place. The accumulated oil in the annular space is naturally at the top of the water column and is gradually produced with the gas into the tubing. The inhibiting solution is introduced into the annular space along with the incoming gas, and it falls freely along the tubing and casing sides until it reaches the fluid level. A hydrocarbon base inhibitor dissolves in the oil layer and is produced slowly through the gas-lift valve. The emulsion type inhibitor penetrates slightly into the water zone but proceeds downward very slowly. The high specific gravity inorganic type falls through the oil rapidly without mixing and then mixes slowly with the water as it proceeds toward the bottom of the annular space and is produced up the tubing. This demonstration was assumed to indicate the probable mechanism of the action of the inhibitors in the field.

It is not within the proposed scope of this paper to discuss the suitability of different substances in inhibitor compositions. Other than the functions of specific gravity and oil solubility in inhibitor action, there are several other factors which must be considered and which can be briefly outlined. The produced waters from the wells under discussion, in common with the waters in the deeper zones on the Gulf Coast, are highly saline and contain considerable concentrations of magnesium, calcium, strontium, and even barium ions. Considerable difficulty

* These are proprietary corrosion inhibitors marketed by the Tretolite Company under U. S. Patent RE 23,227.

from reaction with the inhibitor and precipitation of insoluble salts is experienced. The various alkaline treatments and the use of sodium dichromate were found to give serious plugging difficulties. The waters are very often saturated with respect to calcium salts so that adding gas and other inorganic salts, changes in temperature, and separation of the gas at the wellhead tend to cause deposition of insoluble carbonates. It is quite common for a well to be corrosive at the bottom and be depositing calcium carbonate scale in the gathering lines. The addition of inhibitors which form slightly soluble salts may aggravate this condition. The choice of an inhibition agent therefore requires the consideration of possible reactions which might take place with the produced water.

Other Mitigation Methods

In light of the difficulties encountered with the liquid injection of inhibitors, other methods of corrosion mitigation may well be considered. The introduction of inhibitor in the form of solid pellets or as liquid in capsules seems worthy of consideration. A simple mechanism for introducing sufficient quantity into the annular space, however, has posed a problem which has not yet been economically solved. Weighted sticks of inhibitor have been lubricated down the tubing, but no evaluation has been made of their effectiveness. The use of plastic coating and alloy tubing would obviously eliminate the problems inherent with inhibition treatments if they are resistant to the corrosive environment. The evidence to date is too inconclusive to indicate clearly that the additional cost of these materials is a solution of the corrosion problems. Special mechanical systems such as dual strings or special valve systems for delivering periodic slugs of liquid at bottom have been consid-

ered but at present are too embryonic to discuss. It is believed that if the problem is fully appreciated, systems will be devised which will enable the corrosion engineer to combat the problem better than with the means now used.

Conclusions

It seems evident that CO_2 corrosion in oil wells follows the same general rules of severity established for the corrosive condensate wells; however the difference between reservoir pressures and surface pressures makes corrosion of surface coupons a poor criterion for estimating the maximum rate of attack. The down-the-hole coupon method affords a means of checking both the rate of attack under the most severely corrosive conditions and the measure of protection achieved in the most severely corrosive zones. Difficulties were brought to light by this method when various inhibitors were used, which showed that the corrosion engineer will be faced with a number of new problems as he attempts to mitigate the corrosion in the deeper oil wells. The wells on gas lift where the gas-lift valves are set above the zone of highest corrosive attack afford a most difficult inhibition problem. The down-the-hole coupon method is extremely useful in obtaining an evaluation of the effectiveness of inhibitors in such situations. The development of new inhibitors, treatment methods, or possibly different well completion methods is indicated to combat this increasingly serious production problem.

Reference

1. D. A. Shock and J. D. Sudbury. Prediction of Corrosion in Oil and Gas Wells. *Pet. Eng.*, 23, No. 8, B86, July 15, 1951; *World Oil*, 133, No. 5, 180 (1951).

NACE Requirements on Acceptance and Publication of Papers

(Quoted from "Guide for the Preparation and Presentation of Papers." National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Texas.)

These instructions and suggestions govern preparation of papers for publication in *CORROSION*, and for presentation at meetings of the National Association of Corrosion Engineers. Papers may be submitted for consideration without invitation.

Papers submitted are subject to the publication rules and policies of NACE until released, or unless withdrawn by the author prior to presentation or publication. Papers shall not be a rewrite of material presented elsewhere. The same material shall not be rewritten for presentation or printing elsewhere, except that in some cases an article may be rewritten and pointed toward a particular industry without coming under this restriction. After publication in *CORROSION*, it is the policy of the Association to give permission to reproduce *CORROSION* articles verbatim. Such permission shall be requested in writing. Full credit must be given NACE as the original source.

Potential Measurements in Cathodic Protection Designs★

By ROBERT P. HOWELL

Introduction

WHEN is cathodic protection effective? The only sure answer, of course, is when no further corrosion occurs on the protected structure. To get this answer will take time—many months or even years. Yet the corrosion engineer, in designing and testing his cathodic protection system, needs to know without delay whether or not he has achieved protection. From the standpoint of ideal design, moreover, the protection should be just adequate—no more and no less. Less than complete protection will leave some corrosion occurring at critical points. Too much protection, on the other hand, is wasteful—wasteful of electric power or anode materials or both.

Electrochemical theory indicates that cathodic protection is effective when the current impressed upon a structure is just adequate to prevent a loss of current from anodic areas; the structure then picks up current over its entire surface, and there is no opportunity for the localized loss of current that shows itself as corrosion. Since the structure is buried and we cannot observe what is happening to the corrosion currents, there is no direct means of determining when protection has been obtained. The practical problem confronting the corrosion engineer, therefore, is to devise measurements that will enable him to conclude whether protection is effective. These should be simple measurements of *potential*, if possible, rather than more complex testing techniques. This paper will describe some of these measurements and will relate a few experiences that corrosion engineers have had with them.

Criteria for Protection

A number of different criteria have been used as targets for effective cathodic protection. The most common are:

Current Density

Experience and laboratory tests have shown that complete protection of steel can be achieved at initial current densities ranging from less than 1 ma. per sq. ft. in mild soil to about 10 ma. per sq. ft. in sea water. The method can be quite useful when the current density required for protection is known and the design of the structure lends itself to reasonably accurate determination of current pickup. Current densities in soils are calculated from measurements made with the McCollum earth current meter or similar instrument; this technique requires an excavation at



ROBERT P. HOWELL—Since 1936 he has been with Engineering Department of Standard Oil Company of California. He presently is Supervisor, Electrical and Mechanical Division, and specializes in power plant and utility system designs and in application of cathodic protection to pipe lines, marine structures and process equipment. He holds an ME degree from University of Washington from which he graduated in 1934.

Abstract

Criteria for determining effective cathodic protection are listed as: 1) Current density. Useful when current density required for protection is known and the design of the structure lends itself to reasonably accurate determination of current pickup. 2) Potential change. The author believes a potential change of 0.3 volt is adequate but suspects it results in over-protection. Polarization effects may obscure significance of measurements. 3) Current-potential curves. Elaborate equipment is required and the method is time consuming. 4) Copper-Sulfate Potential. The accepted criterion of 0.85 volt loses some of its validity in highly aerated soils.

Methods, instruments, techniques and examples of potential measurements are given. Multiple-rectifier systems, pipe lines in salt water, steel structures in salt water, and oil and gas well casings are considered.

each point of the measurement, and as a result is both expensive and time-consuming.^{1, 2}

Potential Change

A number of published reports have suggested that protection is achieved when the potential of the line or structure is made more negative to its environment by perhaps 0.25 to 0.35 volt. Our experience has been that such a potential change of 0.3 volt is adequate, but we suspect that it may actually result in considerable over-protection. The significance of this measurement may be also obscured by polarization effects. For example, a 0.3-volt change may be obtained when protection is first applied, but later interruption of the current may give only a 0.1 or 0.2-volt change depending on the time allowed for depolarization.

Current-Potential Curves

Hadley, Pearson, and others some years ago developed a method for direct determination of the current needed for cathodic protection.^{3, 4, 5} The tests are time-consuming, and the method requires elaborate

★ A paper presented at a meeting of Western Region, NACE, Los Angeles, Cal., November 9, 1951.

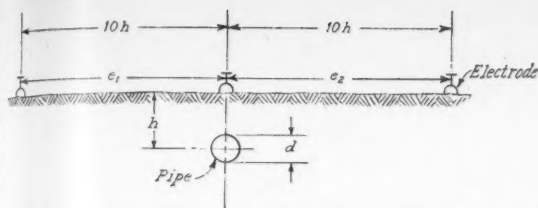


Figure 1. Method for measuring soil resistivity in making Single-Point measurement.

equipment and sources of drainage current with greater capacity than will be used ultimately for protection. Our experience indicates that the refinements of this method are warranted only for critical structures involving large investments, and perhaps also if inconclusive results are obtained by other tests.

Copper-Sulfate Potential

The most generally used criterion of protection is that the line or structure be maintained at a potential 0.85 volt negative to a copper-sulfate electrode. (This value is equivalent to 0.77 volt negative to a saturated calomel electrode.) A number of authors have presented a theoretical basis for this figure; one of the most comprehensive reports was published recently by the National Bureau of Standards.⁶ To be strictly correct, the 0.85 volt must be the true potential, without voltage drops resulting from the flow of protective current through soil and coating. Also, there is considerable evidence that the criterion loses some of its validity in highly aerated soils. In spite of these limitations, however, this criterion of protection is the most convenient of all.

The corrosion engineer should be familiar with all of these criteria if he is to do a competent job when confronted by the usual wide varieties of field situations. Specific applications will be considered after a brief review of the methods by which potential measurements are made.

Potential References

The beginning corrosion engineer (and also his management) is often surprised at the equipment needed for potential measurements. It is quite natural to ask why such a simple problem as measuring the potential between a pipe line and soil requires special gadgets. The basic points of the measuring circuit are two: one is the ground, the other is the pipe line.

An obvious starting point would be to drive a steel pin or pipe into the ground and attach the instrument lead to it. Or even simpler, bury the end of the lead and thereby obtain "contact" with the ground. This method does not work. The readings are erratic and cannot be reproduced. The driven pin or other contact has its own potential to ground, and this potential is the result of soil chemicals, aeration, and many other factors. It is also affected by any current drawn by the measuring instrument. A more stable reference is what the electrochemist calls a "reference half-cell." The most common type in field work is the so-called copper-sulfate electrode. This electrode makes

it possible, in effect, to connect the instrument to ground through a "bridge" of copper sulfate solution. The use of the electrode for this purpose introduces into the measuring circuit a relatively constant potential of about +0.316 volt referred to a normal hydrogen electrode. In practice this potential is neglected, and it is included in the -0.85 volt criterion previously mentioned.

Another type of reference half-cell is the calomel electrode, which is frequently used in laboratory work and in sea water measurements. The author has not used it for field tests because it appears to have no outstanding advantages over the copper-sulfate electrode.

Some corrosion engineers use metal reference electrodes, such as permanently buried pieces of rusty iron and stainless steel. These electrodes are of value in determining changes in potential at various points on an operating cathodic protection system.

Instruments

The subject of potential-measuring instruments in cathodic protection work is worth a paper in itself. A few of the most important types will be considered briefly here and the reader is referred to the bibliography for more detailed description of the instruments.^{7, 8, 9}

1. *Standard-Cell Potentiometer*—This instrument is rather awkward to use and has an upper limit of 1.1 volts unless a voltage divider is added to extend its range.
2. *Vacuum-Tube Voltmeters*—A number of vacuum-tube voltmeter circuits have been developed and reported on favorably by corrosion engineers. They have not come into general use, apparently because they offer little advantage over the older types of instruments and have some maintenance disadvantages.
3. *High-Resistance Voltmeters*—(200,000 ohms per volt or more). These instruments are reasonably rugged and yet adequately sensitive for most potential measurements. Some engineers prefer them to all other types.
4. *Potentiometer-Voltmeter* (Rhodes design)—This instrument can be used either as a standard voltmeter or as a potentiometer-type instrument which draws no current when balanced. In the opinion of many corrosion engineers, this is the best all-around instrument for its purpose.
5. *Combination Units*—Since corrosion and cathodic protection tests frequently involve measurement of potential, current, and soil resistivity, there has been some demand for a single combination instrument to replace the several individual instruments normally required for such work. A versatile instrument of this type has been described in the literature and is available commercially.⁷ This instrument should be quite useful where compactness and ease of transportation is a factor and where measurements of current and potential are to be made at one point. A possible disadvantage of the instrument is that difficulty

with any of its components requires that the entire instrument be returned to an instrument shop or to the manufacturer for repairs. For this reason, many engineers prefer to have available an adequate number of ammeters, voltmeters, and potentiometers so that field work can continue even if some instruments are out of service.

Examples of Cathodic Protection Measurements

The case histories of the author's corrosion group contain many applications of the various measurement techniques just discussed. A few examples should be of interest to engineers who may find some of them similar to problems encountered in their own work.

Single-Point Measurements

When it is desired to check the effectiveness of cathodic protection at a single point on a pipe line, it is usually adequate to determine the pipe-to-soil potential with the copper-sulfate electrode directly over the line or group of lines. Either 0.85 volt to copper sulfate or a 0.3-volt change from the unprotected value may be used as a criterion of protection. It is customary to neglect the IR drop through the soil even though a slight error may result. On the other hand, with a poor coating or bare pipe it may be worthwhile to check surface potential gradients and estimate the current density at the pipe surface. The soil resistivity must first be measured with a Megger, Shepard canes, or other device. The current pickup can be roughly approximated by a number of formulas, of which the following is as useful as any.

$$j = \frac{160e}{\rho d} \quad (\text{See Figure 1})$$

where j = current density at pipe surface, ma./sq. ft.,

$e = \frac{e_1 + e_2}{2}$ = average surface voltage drop for spacing of ten pipe depths, millivolts,

ρ = soil resistivity, ohm-cm.,

d = pipe outside diameter, inches.

(See Appendix for development of formula.)

Regardless of copper-sulfate potential, if this check showed a current pickup of 1 ma. per sq. ft. or more in soil, we would probably assume that the protection is adequate; at any rate, we would not spend much money to drain more current unless it became evident that corrosion had not been arrested.

For lines protected with magnesium anodes, potentials to a copper-sulfate electrode over the lines usually give the best indication of protection. The current densities are usually such that soil gradients are negligible, and an economical spacing of anodes usually results in fairly uniform potentials along the line.

Multiple Rectifier Systems

A problem that frequently arises on cross-country pipe lines is the initial sizing of rectifiers on a multiple system. Much has been written on this problem. A relatively simple method which has been found to be satisfactory and reasonably fast is described here.

An approximate theoretical design of the cathodic

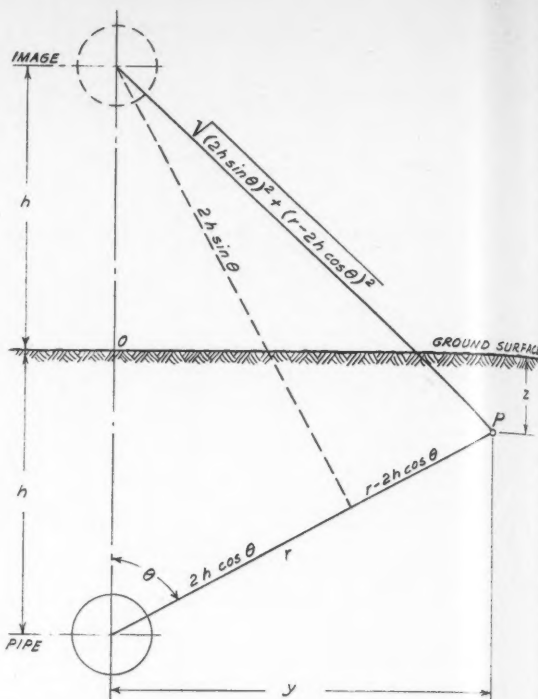


Figure 2. Method of images used in measuring current pickup in soil.

protection system is first worked out, using available information on soil resistivities, probable coating conductivities, and other factors. Anode sites are then selected and permanent anodes and lead cables are installed. Test leads for soil potentials and current spans are attached to the line at the drainage points and usually at three intermediate points. Welding generators are used as temporary sources of current at two adjacent locations. If possible, portable "walkie-talkie" radios are used to facilitate communication. The test procedure consists of establishing the amount of current required at each location to provide a desired potential at a selected "mid-point" between the welding sets. This midpoint is the location at which no current is flowing in the line; in other words, it fixes the end points of two sections of theoretically "finite" lines.

It is usually necessary to make a number of adjustments in the welding generators before the currents at the two drainage points required for establishment and protection of this midpoint can be determined. When the tests for one section have been completed, a generator is leap-frogged to the next span and the measurements repeated. It will not usually be possible to obtain just the necessary minimum protection at the midpoints of successive spans. Some over-protection is inevitable because of the characteristics of the system and the varying spacing of rectifiers.

Pipe Lines in Salt Water

Cathodic protection of pipe lines in salt water gives rise to many interesting and sometimes puzzling phenomena. Protection is accompanied by the deposit of a white calcareous coating ranging in

thickness from a few hundredths of an inch to several inches. The so-called "polarization" effects are much more noticeable than on structures in soil. As protection becomes effective and deposits form, the potential of the structure gradually shifts in the negative direction and may reach greater negative potentials than would normally be encountered in soil.

Another factor to be taken into account is that lines in salt water are usually in critical services—harbor crossings or submarine pipe lines serving to load or unload tankers. Since leaks in such lines may be both expensive and detrimental to public relations, it is usually desirable that no chance be taken with corrosion. Also, since electric power costs on such relatively short lines are usually not significant, no great expense will result from insuring that protection is adequate.

An example of such a line is a harbor crossing of the author's company in the Los Angeles area. It is an 8-inch line, 700 feet long, insulated on shore at each side of the crossing. The line was installed with reclaimed pipe and very poor coating. No leaks had occurred, but cathodic protection was applied a few years after the crossing was installed. When protection was first applied, sufficient current was drained to change the potential by three-tenths of a volt. With continued protection the line became increasingly "polarized." Conditions are now quite stable, and we obtain a potential across the insulating flanges of 0.75 volt with a current drain of 20 amperes. To a copper-sulfate electrode on shore the line measures 1.25 volts at this current. Immediately after the rectifier is turned off, however, the potential across the insulating flanges is 0.65 volt and the copper-sulfate potential to ground is 1.15 volts. Perhaps this copper-sulfate reading indicates that we are overprotecting the line to an unwarranted degree, even though the potential change is only 0.1 volt, but we would not consider discontinuing drainage until the line depolarized to a value of 0.85 volt to copper sulfate. Since the total cost of protection is less than \$100 per year, we plan to continue with the present current.

Another interesting example of measurement problems is a long submarine line extending from shore out to tanker moorings. Some of these lines in the author's company are 4,000 feet long and up to 18 inches in diameter. With a few exceptions, they are constructed of bare pipe and are as much as 20 years old. Protection of these lines requires very large currents at relatively low voltages. Because of the electrical characteristics of the system, considerable overprotection near shore is inevitable for minimum protection at the seaward end. The problem, then, is to determine how much current must be drained at the shore to provide this minimum protection at the far end. Again the potential-change method seems to be a satisfactory working tool.

At a typical terminal, the submarine lines are insulated at the shore and are paralleled by telephone cables out to the moorings. Using the telephone cables for test leads, it is possible to obtain potential measurements at both ends of the line with respect

to a shore reference. As a preliminary criterion, it has been found that protection is assured if the drainage at the shore results in an "absolute" change in potential at the seaward end of 0.2 volt. This potential is measured with the use of the telephone cable and is usually referred to the shore piping or other reference entirely out of the anode field of the cathodic protection system. Whenever possible, we also make intermediate contacts along the submerged line with the help of a diver. From measurements to these points the "attenuation" characteristics of the line can be determined and the actual current density computed. On large bare lines the 0.2-volt change represents a current pickup of about 4 ma. per sq. ft. on old pipe and perhaps 5 to 6 ma. per sq. ft. on a newer line recently placed under protection.

Steel Structures in Salt Water

The protection of steel structures in salt water offers the corrosion engineer many problems in both design and field testing. For such installations it has been found that a current density basis is usually best for design, but structure potentials should be checked whenever it is possible to do so. An example of such an application is the large company wharf on the shore of the Persian Gulf. Extremely rapid corrosion was evident even before the wharf was completed, and it was decided to apply cathodic protection to the submerged portions of the steel piling. Preliminary calculations led to the conclusion that magnesium anodes suspended between the piles offered the most certain means of obtaining protection. With the assistance of the Dow Chemical Company, a design was developed which provided an ultimate current density of 3 ma. per sq. ft. on the submerged metal surfaces. This value was selected because Dow's studies had shown that this was about the minimum to protect a polarized surface in sea water.

If the surface were not already polarized, at least twice this current, or perhaps more, would be necessary to control corrosion during the rather long period that the polarization film would take to build up under conditions of relatively low current density. This design used vertical "Galvoline" magnesium strips which produced high currents for a few days until they were completely consumed and the structure polarized. Thereafter the suspended anodes maintained protection at the lower value.

Another application of cathodic protection that shows great promise is the protection of steel condenser or cooling coils in salt water. Both rectifier and magnesium anode systems have been used, but there is an inclination to prefer magnesium because of its simplicity of application. Recent installations have been designed for an initial current density of 10 ma. per sq. ft. At this density, polarization of the surface progresses satisfactorily, and within a month the potential of the surface to copper sulfate is uniformly well over one volt throughout the structure. When this degree of polarization has been achieved the resistances in the leads is increased and the output is reduced to a current corresponding to about 5 ma. per sq. ft. This current density then maintains the potential level and protection.

Well Casings

One of the biggest unexplored applications for cathodic protection is the casing of oil and gas wells. The many tests on well casings reported in the literature only serve to emphasize the nature of the measurement problem. The author agrees with Ewing and Bayhi¹⁰ in their report of tests in the Loudon Field that the only criterion of protection offering much promise is the plotting of current-potential curves by the method of Hadley and Pearson. In tests made on well casings a sharp break consistently occurred at the current required for protection. The author's principal reservation regarding such tests is that the test equipment may "see" only a part of the casing and corrosion may not be arrested at greater depths. It appears that considerably more research on this point is necessary before this method can be used with assurance on well casings of any depth.

Conclusion

From this review, it is concluded that the application of cathodic protection is still more of an art than a science. The corrosion engineer can have no fixed and unchanging standards for his design, but must keep his eyes open and use his best judgment in the face of puzzling and often contradictory results.

References

1. R. B. Mears, and J. M. Bialosky. Laboratory Methods for Determining the Current Density Required for Cathodic Protection, "Cathodic Protection—A Symposium," published by the Electrochemical Society and National Association of Corrosion Engineers, (1949) 37.
2. N. P. Peifer. Current Required for Cathodic Protection, "Cathodic Protection—A Symposium," 47.
3. J. M. Pearson. "Null Methods Applied to Corrosion Measurements," *Trans. Electrochem. Soc.* **81**, 485-510 (1942).
4. S. P. Ewing. Determination of Current Required for Cathodic Protection, *Proc. AGA*, **1940**, 613.
5. Logan, Pearson, Hadley, Denison and Smith. "The Determination of Current Required for Cathodic Protection," *Pet. Engr. Reference Annual*, **1943**, 168.
6. W. J. Schwerdtfeger and O. H. McDorman. Potential and Current Requirements for the Cathodic Protection of Steel in Soils, *Journal of Research of the National Bureau of Standards*, **47**, 104 (R. P. 2233), (1951) Aug.
7. M. C. Miller. Characteristics of Field Use of Electrical Instruments for Corrosion Investigations and Cathodic Protection, "Cathodic Protection—A Symposium," 12.
8. M. E. Parker. Corrosion Instruments, *Oil and Gas Journal*, **50**, 108, 136, 163 (1951) Aug. 9, 16 & 23.
9. American Gas Association, "Reference Book on Instruments for Electrolysis, Corrosion and Cathodic Protection Testing," New York (1951).
10. S. P. Ewing and J. F. Bayhi. "Cathodic Protection of Casings in Loudon Pool," *Corrosion*, **4**, 264 (1948) June.

APPENDIX

Measurement of Current Pickup in Soil

Using the method of images, the current density at any point in the soil is the sum of the current densities referred to the pipe and to its image.

Let j = current density at any point
 i = current pickup in pipe per unit length
 e = potential drop
 ρ = soil resistivity

Then, from Figure 2, the component of current density at P caused by current flow to the pipe is

$$j = \frac{i}{2\pi r} \quad (1)$$

The corresponding current density at P with reference to the image is

$$j = \frac{i}{2\pi \sqrt{(2h \sin \theta)^2 + (r - 2h \cos \theta)^2}} \quad (2)$$

The total current along the radius r is the sum of (1) and the component of (2) in the direction of r , or

$$j_{\text{total}} = \frac{i}{2\pi} \left(\frac{1}{r} + \frac{r - 2h \cos \theta}{r^2 - 4rh \cos \theta + 4h^2} \right) \quad (3)$$

The potential drop along the radius r can be determined from

$$de = j\rho dr \quad (4)$$

$$e = \int j\rho dr \quad (5)$$

Substituting the value of j from (3) and integrating,

$$e = \frac{\rho i}{2\pi} \left[\ln r + \frac{1}{2} \ln (r^2 - 4rh \cos \theta + 4h^2) + C \right] \quad (6)$$

The value of C must now be determined. Taking the potential at O as zero and letting $r = h$ and $\theta = 0$,

$$C = -2 \ln h \quad (7)$$

Then

$$e = \frac{\rho i}{2\pi} \left[\ln \frac{r}{h} + \frac{1}{2} \ln \frac{(r^2 - 4rh \cos \theta + 4h^2)}{h^2} \right] \quad (8)$$

Now convert to rectangular coordinates by the following relations:

$$\cos \theta = \frac{h - z}{r} \quad (9)$$

$$r^2 = (h - z)^2 + y^2 \quad (10)$$

From which

$$e = \frac{\rho i}{2\pi} \left[\frac{1}{2} \ln \frac{[(h - z)^2 + y^2]}{h^2} + \frac{1}{2} \ln \frac{(h + z)^2 + y^2}{h^2} \right] \quad (11)$$

At the ground surface ($z = 0$)

$$e = \frac{\rho i}{2\pi} \ln \left(\frac{h^2 + y^2}{h^2} \right) \quad (12)$$

At the pipe surface the current density is

$$j = \frac{i}{\pi d}; i = \pi d j \quad (13)$$

Hence, from (12) and (13)

$$e = \frac{\rho j d}{2} \ln \left(\frac{h^2 + y^2}{h^2} \right) \quad (14)$$

For convenience, if surface potential measurements are taken ten pipe depths from the pipe centerline (i.e., $y = 10h$), then

$$e = \frac{\rho j d}{2} \ln \frac{h^2 + 100h^2}{h^2} = \frac{\rho j d}{2} \ln 101 = 2.308 \rho j d \quad (15)$$

For consistent units,

$$j = \frac{e}{2.308 \rho d} \quad (16)$$

For the engineer's common units,

$$j = \frac{158.6 e}{\rho d} \text{ or approximately, } \frac{160 e}{\rho d} \quad (17)$$

where j = current density, ma./sq. ft.
 e = voltage drop, millivolts
 ρ = soil resistivity, ohm-cm
 d = pipe diameter, inches

To eliminate the effect of surface potential gradients not caused by current pickup in the pipe, e should be the average of the voltage drops on each side of the pipe.

The Role of Oxygen In Corrosion and Cathodic Protection*

By ROY V. COMEAUX*

SINCE CATHODIC protection was adopted to reduce corrosion rates of underground lines and of tank bottoms in the Baytown refinery, 105 units have been installed. Although there are some coated lines, the structure is essentially bare. Throughout the installation period, extending from 1947 through 1952, design practices have been based on the application of 3 to 5 milliamperes of current per square foot, with additional current being applied if necessary to obtain a pipe-to-soil potential of -0.85 volt to the copper-copper sulfate electrode. These practices were adopted as a result of a comprehensive study of the literature on cathodic protection¹ and of information obtained through contacts with recognized authorities in this field. In the effort to obtain an evenly distributed protective potential, it soon became evident that potentials were affected not only by current distribution to the surfaces but also by the oxygen accessibility. It is the purpose of this paper to describe the role of oxygen in corrosion and cathodic protection of buried or submerged steel structures in the hope that additional study of this problem in dynamics will be stimulated.

Discussion

The application of cathodic protection to the underground lines and tank bottoms in Humble's Baytown refinery was initiated in 1947, when it became necessary to recondition a 440-foot section of 11 parallel lines after only six years of service. Figure 1 shows these lines before back-filling. Figure 2 is a view of these lines at a point where general corrosion was mild and pitting was severe. Figure 3 shows the finished installation. The white appearance of the soil was due to the precipitation of sodium salts at the surface on evaporation of moisture. It is interesting to note that complete protection was achieved with an average current density of 3.5 ma/sq ft although the maximum pitting was at the rate of 200 ma/sq ft. Obviously the mechanism of cathodic protection involves factors other than countering the corrosion current leaving the pipe with a current in the opposite direction; other factors to be considered are discussed in this paper.

Corrosion of unprotected underground lines was especially severe in all areas in which the soil was contaminated by sulfide and sulfite spent caustics.



Figure 1

Abstract

The oxidation of iron is accompanied by the simultaneous reduction of some other material. In the case of buried steel, above pH 4.5 the reduced substance is oxygen. The two electrons furnished by the corrosion of an iron atom reduce one-half molecule of oxygen to hydroxyl ion. Corrosion ceases if access of oxygen to all points of the surface is eliminated.

Complete cathodic protection is achieved when electrons are supplied at the steel surface at the same rate oxygen molecules diffuse to the surface. Current drainage of 1 ma./sq.ft. is equivalent to 6.24×10^{15} electrons/sq.ft./sec.; this amount reduces 1.56×10^{15} molecules of oxygen, or the amount of oxygen in 318 monolayers of water. This establishes the role of diffusion of oxygen in cathodic protection; any factor which affects diffusion of oxygen to the steel surface will affect the current requirements for cathodic protection. The Baytown Refinery cathodic protection system drains 12,000 amperes, an amount just sufficient to reduce one gram of oxygen per second reaching the buried surface area of about 10,000-000 sq. ft. It is roughly estimated that the average thickness of the soil diffusion layer in the Baytown Refinery is equivalent to one inch of quiescent water.

The influence of the thickness of the diffusion layer on the current density requirements for complete cathodic protection can be developed from

Fick's Law of Diffusion in the simple form: $I_a \cong \frac{2.15}{\delta}$ ma./sq. ft. where δ is in centimeters.

Contamination was of such severity throughout the areas in which chemical treating processes were carried out that soil resistances were generally too low to be measured with either the Shepard cane or by the four pin method.

Because of the deteriorated condition of the refinery underground lines, as manifested by high and increasing leak frequency in the immediate post-war period, the -0.85 volt criterion for protection was adopted. On this basis, over one-hundred cathodic

*A paper presented at the Eighth Annual Conference, National Association of Corrosion Engineers, Galveston, Texas, March 10-14, 1952, based on a paper presented at a meeting of South Central Region NACE at Corpus Christi, Texas, October 17-19, 1951.

*Research Chemist, Humble Oil & Ref. Co., Baytown, Texas.



Figure 2

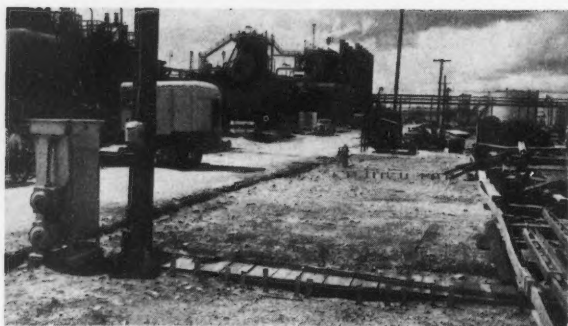


Figure 3

protection units with a current capacity of 12,000 amperes were installed. Rectifiers, such as that shown in Figure 4, are now an integral part of the industrial landscape in the Baytown Refinery. Although practical observations had revealed the dependence of potential on degree of aeration, it is interesting to note that 12,000 amperes of current is just sufficient to reduce one gram of oxygen per second reaching the surface area of several million square feet of underground metallic structures.

In the normal corrosion process oxygen availability differs around the circumference of a line buried at shallow depths; this is particularly true for large diameter lines. It is estimated that 90 percent of all corrosion leaks prior to cathodic protection occurred on the bottoms of lines in the Baytown Refinery, indicating availability of oxygen is an important factor in the corrosion of underground structures. When iron corrodes, or is oxidized, an equivalent amount of some other substance must be reduced. Oxygen is reduced at lower potentials than hydrogen ions or the common metallic ions found in soils; therefore, the amount of iron lost in the corrosion process is equivalent primarily to the amount of oxygen reduced. The iron losses, however, are not necessarily equivalent to the rate oxygen can reach the cathodic surfaces with the result that the concentration of oxygen in the water wetting the surface may be appreciable. But if cathodic protection is applied and it is desired to maintain soil-to-pipe potentials at +0.85 volt to the copper-copper sulfate

electrode, then the amount of current applied must be sufficient to reduce the oxygen at the rate at which it reaches the surface of the structure under protection. Thus, the rate of diffusion of oxygen through soil is a factor that has to be considered in the design of an underground structure if corrosion is to be held at a minimum.

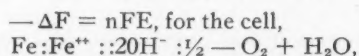
The corrosion occurring as a result of the presence of mill scale on the structures is the cause of many leaks on bare lines at Baytown. The section of a four-inch line shown in Figure 5 failed as a result of this type of corrosion. It is interesting to note that the mill-scale coated surface was stable under potentials not ordinarily considered satisfactory for cathodic protection.

The mechanism by which corrosion of the bottoms of lines occurs while the tops of lines which are more accessible to atmospheric oxygen remain uncorroded has been described. The potentials of the tops of the lines are not considered satisfactory for cathodic protection, but corrosion is negligible, nonetheless. These experiences indicate that protection does not absolutely require highly negative potentials, but rather a stable environment for the products of corrosion. The economic implications of the thermodynamic relation between potential and pH for iron and iron oxides exposed to oxygen in the presence of water were summarized by Pourbaix in the potential-pH diagram presented in Figure 6.

The Role of Oxygen in Electrochemical Corrosion

It is well known that iron corrodes at a negligible rate in neutral water solutions in the absence of oxygen². To obtain the reaction, $\text{Fe}^0 \rightarrow \text{Fe}^{++} + 2\text{e}^-$, the pH of the electrolyte must be low enough to assure a cell potential which will overcome the hydrogen overvoltage of iron. If oxygen is admitted to the cell, however, in such a manner as to form a differential aeration cell, corrosion takes place at the iron surfaces least exposed to the oxygen. The higher the oxygen concentration and the lower the hydroxyl-ion concentration at the cathode, the more noble the half-cell potential of the cathode. The lower the iron-ion concentration, the less noble is the half-cell potential of the anode. The effect of concentration on potential for iron and oxygen electrodes is shown in Table I.³ For given electrolyte resistivity and physical conditions, the greater the difference in half-cell potentials the more rapid will be the corrosion. It is obvious that corrosion currents flowing through metals and soils, both of which have electrical resistance, are accompanied by power losses. It is therefore of interest to consider the source of energy which supplies the power consumed by the corrosion reaction.

It is evident that the corrosion process is spontaneous. If the reaction is spontaneous, it follows that there is a free energy decrease when the reaction occurs. The power loss sustained when charged ions migrate through electrolytes which have resistance accounts for a major portion of the free energy decrease. The free energy decrease,



depends on the concentrations of iron ions, hydroxyl ions and oxygen and is always greatest at the instant of exposure. This means that in a dynamic corrosion system, the concentrations of ions and of oxygen at the electrodes change from their initial values. The oxygen reduction reactions take place at less negative potentials than hydrogen-ion reduction (larger free energy decrease) and are not complicated by overvoltage considerations⁴. It is known that exposure of an iron electrode to oxygen causes the potential to shift in a noble direction. When oxygen becomes available to large cathode areas, the potential difference between cathodic and anodic areas tends to increase and with it the energy available to sustain the corrosion reaction. On the other hand, if oxygen availability at the cathode is limited, corrosion of the anodes will be lessened. As a practical consideration, the greater the quantity of oxygen permitted to contact the steel surface, the greater will be the metal losses.

It is known that depth of immersion and the thickness of films are factors in the corrosion and protection of steel in aqueous solutions, the weight losses decreasing with increasing difficulty for oxygen to reach the metal^{5,6,7}. The measurement of metal losses by oxygen consumption is becoming an increasingly widespread tool in corrosion studies⁸.

The Effect of Oxygen on Current Requirements for Cathodic Protection

In the corrosion process, the free energy relation is such that electrons for the reduction of oxygen are furnished by the iron, which corrodes. Complete cathodic protection is achieved when electrons are supplied from an external source at a rate faster than oxygen can reach the metal. Supplying electrons at a rate insufficient to reduce all the oxygen reaching the surface would still effect:

- 1) a decrease in oxygen concentration,
- 2) an increase in hydroxyl-ion concentration,
- 3) a decrease in acidic ion concentration,

all of which are in the direction of reducing the spontaneity of the corrosion process. Economical protection very likely consists of preventing accumulations of acidic ions in pits on the metal surface, allowing for a slight, generally distributed corrosion such that the metal will last for a desired life. Thus, the effective current density to be applied depends upon the condition of the structure it is desired to protect and its anticipated life. Installations justified on the basis of reducing leaks on a system already badly deteriorated, however, must have as their purpose complete protection, and it was on this basis that the industry accepted the -0.85 volt criterion.

If the electrons supplied to the metal by the external source were not consumed in the cathodic reaction as supplied, the line would become charged to the supply potential and the current would stop. At a given applied current the potential of each square foot of exposed surface is limited by attenuation^{9,10} and by the concentrations of reducible substances at the surfaces. At the metal surfaces the electrons are consumed as supplied primarily by re-

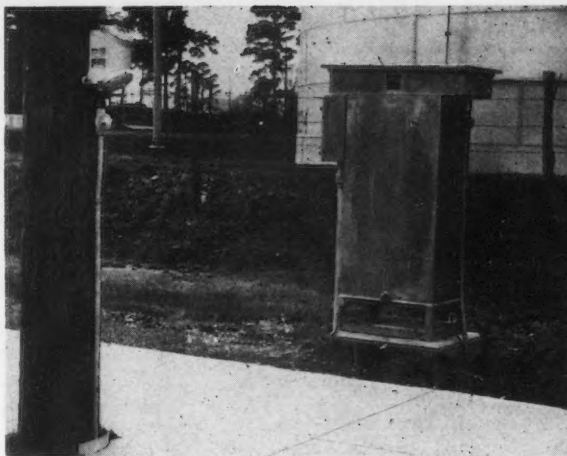


Figure 4



Figure 5

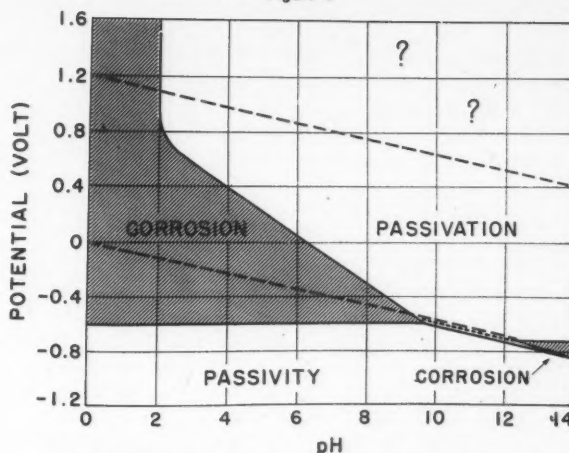


Figure 6—Regions of corrosion, passivity and passivation of iron.

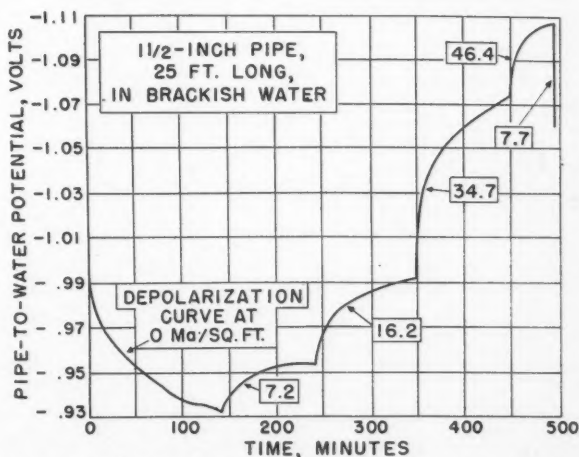


Figure 7—Variation of pipe-to-water potential with time for several current densities.

ducing oxygen to hydroxyl ions and, at sufficiently negative potentials, by reducing hydrogen ions to hydrogen gas. Strictly considering oxygen reduction one milliamperes/square foot, as shown in Table II, is sufficient to reduce the oxygen in 318 monolayers of water each second. From this and the potential versus the logarithm of equilibrium constant diagrams presented by Brown, et al¹¹, it is indicated that the potential obtained for any given current density will depend on the physical diffusion rates for oxygen and the presence of indifferent electrolytes such as chlorides which would reduce the hydroxyl-ion migration. Any condition, such as temperature¹², velocity, deposit or film forming cations, suspended solids, biological fouling, excess of indifferent electrolyte, porosity, depth of burial, particle size, etc., which promotes the development of the diffusion layer or decreases the diffusion rates will minimize current requirements for complete protection.

Sudrabin⁷ and Hill¹³ independently found that varying electrolyte, electrolyte concentration and electrolyte pH between the range of 5.5 and 8.0 at fixed oxygen concentrations did not influence required current densities appreciably. Sudrabin found that at constant temperature and velocity, the required current density is approximately linear with oxygen concentration. Draughon and McNeil¹⁴ found that the average current required to protect open condenser tubes (10 ma/sq ft) was insufficient to protect the surfaces where agitation was vigorous. Without protection, corrosion is often minimized at the points of greatest agitation because the supply of oxygen to these surfaces is greatest¹⁵.

Comparison Between Diffusion Rates of Oxygen and Recommended Current Densities

Oxygen diffuses linearly to some extent across a diffusion layer which, in the case of buried structures, may become quite thick. A paper by Dr. A. Hickling¹⁰, in which the subject of concentration polarization at electrode surfaces was treated, reveals the role of diffusion in cathodic protection (pages 101-103 of reference cited). Though the particular problem with which this paper is concerned differs from that considered by Dr. Hickling, the same line of reasoning may be applied. It would be rather difficult to equate the rate at which oxygen diffuses to the surface physically and from the surface as hydroxyl ions by physical and by electro-chemical migration. If it

is assumed, however, that the minimum current required for complete cathodic protection is that required to react with oxygen as fast as it reaches the surface*, the rate of diffusion of oxygen to the cathode can be equated to the current requirement and the result is essentially the same expression presented by Hickling, though he was considering ions in the presence of an excess of indifferent electrolyte. This expression is:

$$AD(C-C_0)/d = IA/ZF$$

where A = area of electrode, sq cm

D = diffusion coefficient, cm²/sec

C = concentration outside the diffusion layer, gm-ions/cc

C₀ = concentration in the monolayer wetting the electrode, gm-ions/cc

d = thickness of diffusion layer, cm

I = current density, amperes/sq cm

Z = valence

F = 96,500 coulombs

As current density is increased, the equilibrium concentration of oxygen at the electrode surface, C₀, diminishes. As C₀ approaches zero, the concentration polarization for the oxygen reduction process begins to approach infinity, but as the potential becomes sufficiently negative, hydrogen-ion reduction becomes the controlling reaction. The current density at which C₀ approaches zero is called the limiting current density for the oxygen reduction reaction, and this I_a is synonymous with the minimum current density for complete cathodic protection.

At the limiting current density, $I_a = \frac{DCZF}{d}$. A few simple calculations are now in order to indicate the effects of depth of burial on current requirements.

At 18 degrees C, D for oxygen in water is 1.98 X 10⁻⁵ and C = 1.125 X 10⁻⁶.

Therefore, $I_a = \frac{2.15 \times 10^{-6}}{d}$ amp/cm² = $\frac{2}{d}$ ma/sq ft, where d is equivalent to cm of quiet water. Thus, if the diffusion layer were equivalent to one centimeter of quiet water, the current density required to reduce oxygen as it reaches the surface would be 2 ma/sq ft. Additional work is needed to determine diffusion rates of oxygen through soils over the range of variation of moisture contents. Meanwhile, it is roughly estimated that oxygen diffusion through one foot of moist soil and one centimeter of quiet water are of the same order. If the 12,000 amperes applied at Baytown were utilized in the reduction of oxygen on a buried surface of 7.5 million square feet, the thickness of the layer through which the uncharged oxygen molecules would have to dif-

TABLE I—Potentials of Iron and Oxygen Half-Cells

Reduced	Potentials	Oxidized
Fe° (Metal).....	+0.880	Fe ⁺⁺ +2(—)[Fe(OH) ₂ (S) in 1M OH [—]]
Fe° (Metal).....	—0.860	Fe ⁺⁺ +2(—)[Fe(OH) ₂ (S) in Water]
H ₂ ° (Gas).....	—0.828	2H ⁺ +2(—)[in 10 ^{—14} M]
Fe° (Metal).....	—0.440	Fe ⁺⁺ +2(—)[(Fe ⁺⁺) = 1M]
H ₂ ° (Gas).....	—0.414	2H ⁺ +2(—)[(H ⁺) = 10 ^{—7} M]
H ₂ ° (Gas).....	—0.000	2H ⁺ +2(—)[(H ⁺) = 1M]
2OH [—] (1M).....	+0.400	$\frac{1}{2}$ O ₂ °(Gas)+H ₂ O+2(—)
Ag°.....	+0.799	Ag ⁺ +1(—)
2OH [—] (10 ^{—7} M)...	+0.802	$\frac{1}{2}$ O ₂ °(Air)+H ₂ O+2(—)
2OH [—] (10 ^{—7} M)...	+0.813	$\frac{1}{2}$ O ₂ °(Gas)+H ₂ O+2(—)
2OH [—] (10 ^{—14} M)...	+1.228	$\frac{1}{2}$ C ₂ °(Gas)+H ₂ O+2(—)

TABLE II—Oxygen Reduction at Cathodic Surfaces

- (1) Faraday = 96,500 Coulombs
= 96,500 Ampere-Seconds
= 6.02 X 10²³ Electrons
- (2) 1 Ma/sq. ft. = 6.24 X 10¹⁵ E/sq. ft./sec.
- (3) 6.24 X 10¹⁵ Electrons Reduces 1.56 X 10¹⁵ Molecules O₂.
- (4) Water Molecules/Monolayer = 9.7 X 10¹⁷/sq.ft. Oxygen Solubility at 65° F. = 4.9 X 10¹⁵ Molecules/sq.ft.
- (5) Therefore:
1 Ma/sq.ft. Reduces O₂ in 318 Monolayers/sec.

* The paper by Kittelberger and Elm¹⁷ has some interesting data on current density vs oxygen pressure.

fuse could not exceed the equivalent of 1.25 cm of quiescent water at 65° F. It is concluded that a fundamental approach to a solution of the problem of minimum current density for complete protection is through a broader knowledge of the chemical and physical activity of oxygen in the various soils. Should economics dictate less than complete protection, the formula relating current density to oxygen concentration gradient and diffusion coefficient affords a fundamental basis for experiment.

pH as a Criterion of Protection

Although the oxygen reduced at the cathode reaches the surface by a physical diffusion process, the flow of current through the electrolyte requires a transfer of negative ions in the direction of the anode and of positive ions in the direction of the cathode. Of primary concern is what takes place in the diffusion layer at the cathode. Here, each positive ion entering must have a companion negative ion, and because negative hydroxyl ions are produced at the cathode in greater quantity than required for transfer of the negative portion of the current carried by the ions, a build-up of hydroxyl ions at the cathode occurs^{18, 19}. This build-up is limited by diffusion and by the ratio of mole fractions, charges, and mobilities of hydroxyl and other negative ions. When the rate of formation of hydroxyl ions equals the rate of removal by migration and diffusion the potential becomes constant with time. Attention is directed to the potential vs. time data in Figure 7. No effort was made to measure the hydroxyl-ion concentration at the surfaces, but it would be possible to estimate these values assuming the values of potential contained no IR component.

Potential is related to the iron-ion concentration through the Nernst equation. The product of the iron-ion concentration and the square of the hydroxyl-ion concentration at a given temperature is constant (Solubility Product Principle). It is convenient to express hydroxyl-ion concentration according to the pH scale. To the standard hydrogen electrode, the relation between potential and pH for the Fe:Fe²⁺ electrode is expressed by the equation, $E = -0.047 - 0.059 \text{ pH}$ (for equilibrium Fe/Fe(OH)₂).²⁰

The following table indicates the calculated relation of pH at metal surfaces to metal-to-soil potentials measured with reference to the standard hydrogen and copper-copper sulfate electrodes.

Under cathodic protection in the Baytown Refinery, pit products have been found to reach pH values of the order of 10 at potentials of -0.9 to -1.0 to the Cu:CuSO₄ electrode. The high pH values correspond

pH	Reaction	POTENTIAL TO REFERENCE ELECTRODE	
		To Standard Hydrogen	To Cu:CuSO ₄ (Sat.)
4.....	Acidic.....	-0.28	-0.60
7.....	Neutral.....	-0.46	-0.78
10.....	Alkaline.....	-0.64	-0.96
13.....	Strongly Alkaline.....	-0.81	-1.13

to negligible chlorides in the pit products, whereas chlorides were prevalent in pits before protection was applied.

Bibliography

1. F. A. Rohrman, A Bibliography on Cathodic Protection, *World Oil*, **131**, No. 1, 179-190 (1950).
2. H. H. Uhlig, Why Metals Corrode. *Corrosion*, **5**, No. 6, 169-170 (1949).
3. Schoch and Felsing, General Chemistry, First Edition, 1938, Table 25.
4. W. J. Muller, The Effect of Cathodic Reactions on the Corrosion of Metals from the Viewpoint of the Local Cell Theory. *Trans. Electrochem. Soc.* **82**, 76, 167 (1939).
5. U. R. Evans, Metallic Corrosion, Passivity, and Protection, pp. 292-293.
6. F. J. Speller, Corrosion, Causes, and Prevention Second Edition, p. 161.
7. L. P. Sudrabin, Cathodic Protection as a Corrosion Control Method Applied to Steel Surfaces Submerged in Water. *Corrosion*, **2**, 175 (1946).
8. Van Rysselberghe, McGee, Gropp, Williams and Delahay, Polarographic Study of Corrosion Phenomena. *Corrosion*, **6**, 105 (1950).
9. R. Pope, Attenuation of Forced Drainage Effects in Long Uniform Structures. *Corrosion*, **2**, 307 (1946).
10. E. P. Doremus, G. L. Doremus, M. E. Parker, Jr. Engineering Aspects of Cathodic Protection as Applied to Pipe Lines. *Corrosion*, **5**, No. 9 273-281 (1949).
11. Brown, English and Williams. The Role of Polarization in Electrochemical Corrosion. *Corrosion*, **6**, No. 6 186 (1950).
12. Water Problems in Radiant Heating Systems. *The Beta Indicator*, Feb., 1951.
13. W. R. Hill, Laboratory Tests of Cathodic Protection of Steel in Corrosive Solutions, *Petro. Eng.* **12**, No. 13, 51 (1941).
14. Draughon and McNeil, Design of Cathodic Protection for Open Box Coolers, API, Division of Refining, May 2, 1950.
15. Mears and Brown, Causes of Corrosion Currents, *Ind. Eng. Chem.* **33**, 1008 (1941).
16. A. Hickling, The Mechanism of Electrode Processes in Aqueous Solutions. *Quarterly*, **3**, No. 2 95-125 (1949).
17. W. W. Kittelberger and A. C. Elm, Effect of Various Aqueous Solutions Upon the Reactions on Pure Anodes and Cathodes, *Corrosion*, **5**, No. 4 101 (1949).
18. A. L. Kimmel, Special Anodes for Cathodic Protection of Water Tanks. *Corrosion*, **5**, 218 (1949).
19. W. T. Pyatt, Cathodic Protection in Peat Bogs. *Petro. Ind. Electrical Assoc.* **2**, No. 10 61 (1942).
20. M. Pourbaix, Corrosion, Passivity and Passivation from the Thermodynamic Point of View. *Corrosion*, **5**, No. 4 121 (1949).

(See Discussion Page 310)

DISCUSSION

Discussion by Fred M. Cloninger, Texas Pipe Line Co., Tulsa, Okla.:

I would like to compliment Mr. Comeaux on the material presented and especially the manner of presentation. If the conventional slide were not broken I would like to have it. I once asked a college professor to offer a course in corrosion. He answered that it would cause so much conflict between the electrical and chemical departments that no course could be given. Before our conventional concept can be discarded, we will not only have to change our manner of speaking, but also our manner of electrical measurements. What we essentially do is follow the conventional flow of electric current from cathode to anode in the metallic circuit then follow it on around from anode to cathode in the electrolyte. The final result is the same whether it is explained chemically or electrically. I well realize progress is not made without change, but are we ready for a radical change in our concepts?

Author's Reply:

Does the flow of current (conventional concept) to all points of a metallic surface assure cathodic protection per se? What about the cathodic corrosion of amphoteric lead? We can make electrical measurements in the present sound manner, augmented by relatively simple chemical analyses, but why can't the interpretation of these measurements be broadened in the effort to explain the fate of the electrons forced into the metal to achieve cathodic protection? If we are not ready for change in present concepts, are we not ready to admit that current concepts do little to broaden the understanding of the effect of the electrons supplied on the environment? Does not protection result when an environment is maintained in which the metal or one of its corrosion products is stable? Would not a better understanding of the effects of current upon environment and of environment upon current requirements for protection be of major significance in the engineering design of underground line systems? If the answers to the last four questions are in the affirmative, then we should broaden our concepts.

IN CO
ture
tempts
to their
contend
underg
the cat
by nat
dynam
an an
current
through
and co
stray
connec
the d-
The p
natural
In t
result
system
leaking
The m
carry
ground
trical
may fl
the in
loads
potent
with r
the bo
These
sheath
matic
curren
is min
Swi
to wh
consid
potent
plate,
tween
cable
can be
resista
nal re
stray
plishe
narrow
curren

An Improved Electrolysis Switch*

By VERNON B. PIKE*

IN COMBATING the destruction of metallic structures by electrolysis the Corrosion Engineer attempts to keep the exposed surfaces cathodic with respect to their electrolytes. The Telephone Engineer has to contend with such a problem where a bare lead sheath underground cable must be maintained. He produces the cathodic condition either by forced drainage or by natural drainage. When forced drainage is used, dynamic currents are made to enter the earth through an anode and thence into the cable sheath. Any current leaving the cable sheath is made to pass through a metallic conductor bonded to the sheath and connected, in turn, to a d-c generator. When stray currents are encountered, the cable sheath is connected by a low resistance bond to the ground of the d-c power source producing the stray current. The polarity of the power ground is negative and natural drainage keeps the cable sheath cathodic.

In the majority of cases stray current exposures result from the operation of d-c powered railway systems in such proximity to cables that currents leaking from the rails are carried by the cable sheaths. The metallic bonds mentioned above are installed to carry currents from the sheath to the power station ground. If the railway system is viewed as an electrical network, it is easy to understand that current may flow in either direction in some linkages. Under the influence of multiple power supply and shifting loads as one or more trains traverse the system, potentials of the power grounds sometimes shift with respect to the cable so that current may flow in the bond wire from a power ground to the cable. These currents produce electrolysis by leaving the sheath to enter the earth at remote places. With automatic switches operating in the bond wires, reverse currents are interrupted and electrolysis of the sheath is minimized.

Switches are installed after studying the conditions to which the cable plant is exposed. The cable is considered safe if it is cathodic to earth and the potential, as might be measured with a lead ground plate, is a few millivolts or more. The potential between the cable and earth varies differently from the cable to power ground potential but, in general, it can be controlled by designing the bond wire to have resistance bearing a certain relationship to the internal resistance of the leakage paths from which the stray currents are drained. When this is accomplished the cable can be held cathodic within very narrow potential limits even though the drainage currents may vary through a large range. The actual

Abstract

An improved electrolysis switch has been placed in use in the Bell System for mitigation of electrolysis of cables by stray currents. It consists of three relays operating in sequence, namely control, intermediate and drain relays. It automatically closes a drainage bond between a lead-covered underground cable and a power return ground when stray current is picked up by the cable to such an extent as to make some of the sheath positive with respect to its environment. It also opens the bond when the drainage current falls to zero and drainage is no longer required. Two sizes are used capable of draining 200 amperes and 400 amperes, respectively.

Its action is very fast, only .015 second elapsing from the time the control circuit releases until opening of the drainage bond. Separate adjustments are available for setting the voltage at which the switch closes and opens the drainage bond.

A capacitive voltage booster enables switch operation over longer battery power supply wires than is possible if the booster is not used. A power supply unit consisting of a stepdown transformer and selenium rectifier is also available to operate the switch with power drawn from an AC power source if the switch must be installed beyond reach of the battery power.

A sealed steel housing enables the switch to withstand submersion and permits installation in very damp locations.

resistance of any specific ground path need not be known but a single resistance value for the bond can usually be determined which will match the return path to the leakage network, and the cable which might otherwise be destroyed may be held in a safe condition.

From an historical standpoint the first switch to attain standardized use in the Bell System appeared about 1911. It had a rocking armature on which was mounted an inverted U-shaped electrode. The ends of this U-shaped piece dipped into two cups that were partially filled with mercury in order to close the metallic bond between cable and ground. This switch was of the type now called self-actuated, for the solenoid which was associated with the armature was energized by a portion of the current that was carried by the bond. The drainage path was closed by this switch when the cable sheath reached a potential of 0.35 to 0.50 volt positive to the power ground. Considerable current in reverse direction was required to cause the switch to open the drainage bond. The nominal current capacity was 65 amperes. This switch was troublesome to maintain because the mercury was thrown out of the cups when large currents were interrupted.

About 1915 the Dalton, Wittier and True Company sold a switch that was adopted in place of the mercury cup switch. It contained a two winding polarized relay and solenoid contactor capable of carrying 100 amperes. Other switches were developed, each

*A paper presented at the Eighth Annual Conference, National Association of Corrosion Engineers, Galveston, Texas, March 10-14, 1952.
* Bell Telephone Laboratories, Inc., Murray Hill, N. J.

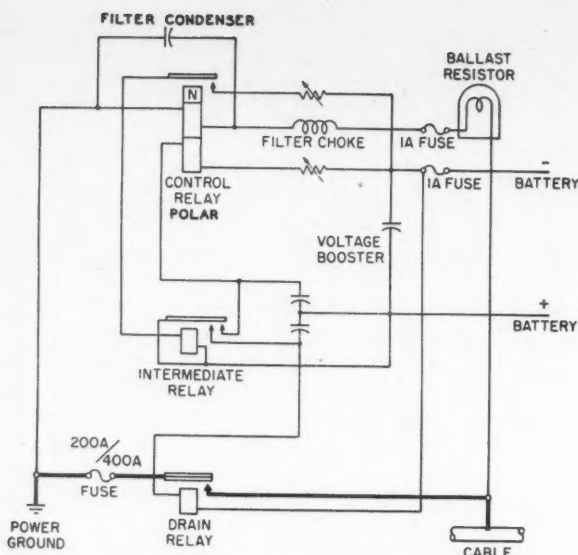


Figure 1—Schematic drawing of electrolysis switch.

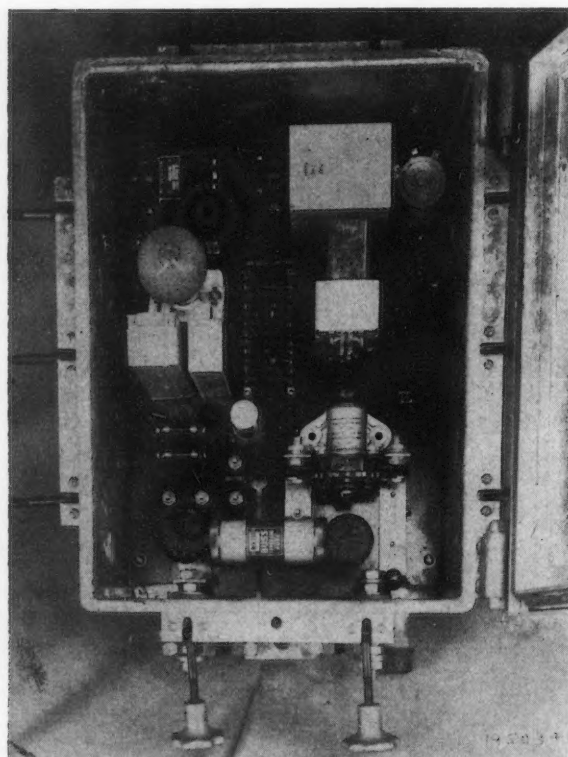


Figure 2—Top view of electrolysis switch with case open.

of which supplanted its predecessor by reason of improvements until the switch I am about to describe was adopted. Additional improvements will undoubtedly be made in the course of time and a new switch will take its place.

The severest exposure our switches must withstand in bond wires is caused by large amplitude rapid current reversals. We have found with the aid

of the oscillograph that transient potentials reach as much as 300 volts and polarity reversals occur at rates as high as 2000 per second. It is apparent therefore that the switch should open the drainage bond when the current is zero or very close to zero. Drainage bonds have very low impedance and a great deal of the maintenance results from burning of the contacts of the drain relay. It is obviously impossible to have the contacts of a heavy duty drain relay separate fast enough to interrupt all transients close to zero. It is only practical to open the switch as quickly as possible when the current approaches zero and thereby interrupt the greatest possible percentage of surges before arcing can develop. The switch that has recently been developed includes the fastest acting relays we could find and requires about 14.5 milliseconds from the time the control relay releases until the drainage bond is open. We believe that it is this speed of release plus availability of precise adjustments that has made its performance superior to other switches we have used. The new switch is made in two sizes capable of draining 200 amperes and 400 amperes. Silver contacts are used in the drain relay and the total resistance between the drain terminals at the outside of the switch has been held to about .001 ohm with the drain contacts closed.

Referring to the circuit schematic Fig. 1; the control circuit consists of a polarized relay which is protected by an a-c filter, a lamp ballast and fuse. This circuit is connected directly to the drainage bond by jumpers. Provision is made to carry the control wires outside of the switch case for connection to the bond wire at remote points if adequate control voltage cannot be obtained at the switch. As yet we have never had to resort to this type of connection but thought the provision should be included to be able to get switch operation under the most extreme conditions. When the control relay operates, battery current causes the intermediate relay to operate and then in turn, the drain relay closes the drainage bond.

Closing the intermediate relay also enables battery current to flow through the hold coil of the control relay and aids in holding the control relay operated. Current through this hold winding is adjusted by decreasing or increasing the resistance in the circuit when the switch is installed. The current that flows in the control winding when the switch is closed varies in proportion to the current in the bond wire. Since the flux produced by the current in the control winding and that produced by the current in the hold winding are additive when the switch is closed, release can be made to occur exactly when the drainage current is at any desired value whether it be in one direction or the other or is passing through zero. This precise adjustment makes it possible to overcome recycling or chattering that has been encountered in some of our older switches.

The switch that was in use before this one was developed had only two relays, namely the control relay and the drain relay. We found that erosion of the contacts of the control relay by the battery current necessary to actuate the drain relay gave rise to considerable maintenance. This has been overcome in the new switch by adding an intermediate relay. The

intermediate relay that is used requires only three milliamperes for operation whereas the drain relay requires more than 250 milliamperes. The contacts of the intermediate relay are continuously wet with mercury and are capable of controlling the battery current to the drain relay without serious deterioration.

The new switch requires a minimum operating power potential of 18 volts and is intended to receive this power from a 48-volt Central Office storage battery. This power is transmitted to the switch over cable pairs and consequently the economic distance from the Central Office to the switch is limited. In order to augment the power supply a capacitor is included in the switch and is connected directly across the power supply terminals. This capacitor enables satisfactory switch operation over much longer cable circuits than would be possible without it. For example the current to hold a relay in the operated position is less than the current required to make it operate. The capacitor is used to store up energy when the switch is in the unoperated condition and surrender part of this charge and assist the battery when switch operation is required. This capacitor enables us to operate the switch over a loop of 250 ohms whereas if it were not used the maximum loop resistance would be about 111 ohms. The value of this capacitor is such that the charge is restored in about .03 second after the switch release occurs. This feature has worked out very well and to date we have had no difficulty due to insufficient charge being available to operate the switch.

Provision for operating the switch beyond the reach of battery power is made by the development of an a-c power panel that can be mounted inside the switch case. This unit utilizes a step-down transformer and small selenium rectifier. Smoothing of the pulse is accomplished by the same capacitor that is

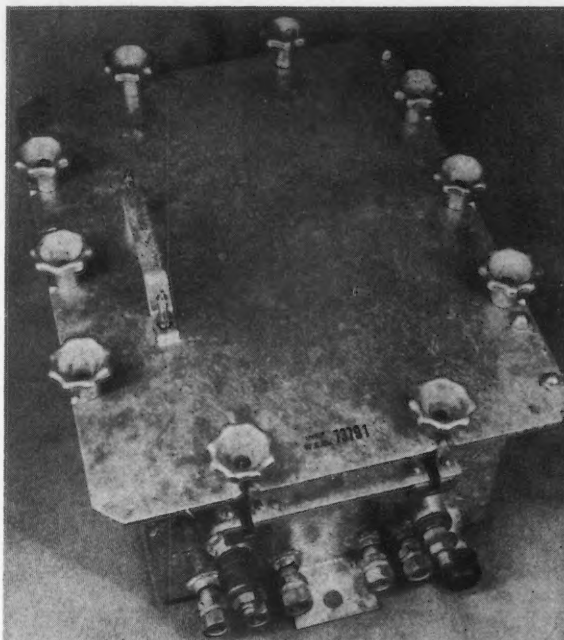


Figure 3—Electrolysis switch with case closed.

used as the voltage booster on battery operation. The a-c power panel is an auxiliary unit and is installed only when a-c power has to be used in operating the switch.

A steel case which has a hinged and gasketed cover has also been developed. Screw clamps are provided for making the case hermetically tight so that the switch can be submerged without injury and operation is possible in very damp locations.

Figures 2 and 3 show the switch with the case open and closed, respectively.

(See Discussion Page 322)

NACE Practice on Reprinting Technical Material

Requests for prices on reprinting material appearing in *CORROSION* should be addressed to National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas. Prices usually cannot be given until after articles have appeared in *CORROSION* although requests for prices may be submitted at any time. Type from which technical articles are printed is kept standing for 90 days after date of issue, and reprints ordered during that interval will be from standing type. For reprints ordered after expiration of this period, write for details. Single copies of reprints of material from *CORROSION* are listed in advertisements appearing in

many issues. Usually single copies may be obtained only in the form of tear sheets, or whole copies of the issue in which the article appears.

Permission to reprint articles usually is given to responsible firms and individuals who wish to have the work done themselves. NACE requires, however, that proper credit be given *CORROSION* at an appropriate place on all reprint material. The association also requests that reprint style closely conform to that approved by its board to be in keeping with the aims and objectives of the association and that copies of reprints made under this authority are supplied NACE for recording purposes.

Cathodic Protection at Steam-Electric Generating Stations*

By J. H. COLLINS and E. H. THALMANN*

History

PRIOR TO World War II, a number of the client companies of Ebasco Services, Inc., operated both electric and gas systems. The Ebasco Corrosion Department had been actively engaged assisting many of these companies in the solution of corrosion problems associated with gas operations, but little work had been done at electric generating stations.

After the cessation of hostilities there was a tremendous increase in the construction of new generating capacity. With cognizance of the advances which had been made in corrosion mitigation the Corrosion Department was asked to observe design and construction practices and to make recommendations for protective measures for a number of projected generating stations. As a result of successful experience with initial installations, cathodic protection and other measures have been included when desirable in the construction of new steam electric generating stations and have been applied to a number of older stations at which corrosion damage has been experienced.

Problem

In the usual steam electric generating station a large galvanic cell of dissimilar metals is established due to a grounding-grid consisting of high-conductivity bare copper cables and ground rods, which are installed for safety to personnel and equipment at time of electrical ground fault. This extensive copper cathode is connected electrically to oil, gas and water piping, as well as to metallic cable sheaths and conduits. The system of surface structures is made electrically continuous and is thoroughly interconnected for electrical safety, increasing the severity of the galvanic cell. In addition, there are the usual local action cells due to differential aeration, ion concentration, differences in soil types, etc.

In general the resistance to earth of the station grounding system is in the order of 0.01 ohm. This low resistance would allow considerable galvanic current to flow if no steps were taken to mitigate the corrosion cell. As a further generalization, where a low-resistance station ground is readily attained, corrosion is more severe than at stations where grounding is a problem, as soil resistivity is generally found to be high for the latter class.

In some instances, where the grounding grid and piping are in soil of high resistivity, deep water-well casings extending into soil strata at lower resistivity are connected to the grounding grid to reduce the

Abstract

Corrosion of underground structures, applications of cathodic protection and testing procedures are discussed. Piping, cable sheaths and other structures at electric generating stations are solidly connected (for safety of personnel during power fault conditions and for reduction of the station ground resistance) to the station grounding system, which generally is an extensive grid of heavy bare copper cable and ground rods. The resulting galvanic cell is an important factor in corrosion, particularly when the structures are in low resistivity soil. Current requirements for cathodic protection range from 50 amperes to several hundred amperes, supplied from rectifiers and graphite anode-coke breeze ground beds. Choice of ground bed locations is restricted by the need of avoiding proximity to underground structures. The station grounding system generally is connected to transmission line shield wires or counterpoises, or to transmission cable sheaths which take a part of the cathodic protection current. Precaution to avoid shock hazards during power faults is necessary in isolating incoming pipe lines. Pronounced shielding effects result from large pipe lines, multiple cable runs and reinforcing steel in concrete mats. Testing procedure includes checking continuity of the grounding system and tests of current distribution, potential changes and polarization effects to determine protection. Circulating water intake screens, spillway gates and other isolated structures require separate additional protective installations.

station ground resistance. Such well casings present the problem of small anodes coupled to large cathodes.

Cinders were used as a fill in some of the older generating stations. This constitutes a separate problem from the usual case, and it may not be possible to achieve complete cathodic protection because of the shielding action of the partially burned carbon particles in contact with the metallic sub-structures.

It has been found at several stations that mist from low resistivity water in a spray pond or cooling tower has lowered the resistivity of adjacent soil after several years operation, creating a large concentration cell.

In 1945-46 we were assisting in the application of cathodic protection to the underground lead-covered cable distribution system in Miami, as well as on several submarine cable crossings. At that time, the client company asked us to investigate, from a corrosion viewpoint, the underground structures at the two new generating stations under construction. One of these stations is located on the east coast of Florida, and the other is located on the west coast, at approximately the same latitude.

At first glance it might appear that the corrosion conditions might be almost identical at both these locations because general features were similar. For example, both installations used sea water for condensing purposes.

The soil at one station is fine beach sand, having

* A paper presented at the Seventh Annual Conference, National Association of Corrosion Engineers, New York, N. Y., March 13-16, 1951.

* Both with Ebasco Services, Inc., New York, N. Y.

resistivity in the order of half-a-million-ohm-cm. The switchyard was isolated from other structures, and its resistance to remote earth measured in excess of 1 ohm, the value specified as a maximum on the switchyard grounding drawing. An interesting side light is that extremely low resistance to earth was obtained by bonding the switchyard ground to the interlocking steel piling along the shore.

Tests at the other site showed the resistance of but one ground rod to be approximately 2 ohms, since the soil was low-resistivity clay. Little external corrosion on underground metallic structures in contact with the sand would be expected, but considerable corrosion would be expected at the site where clay soil was found.

At a station in West Texas, the surface soil is largely sand with a small amount of silt or clay. At about one-foot depth hard caliche rock is encountered and trenches have to be cut with an air drill. The caliche rock, when dry, has a high resistivity, but when wet with distilled water, has a resistivity of about 1450 ohm-cm. The surface sand was found to be sufficiently contaminated so that when wet with distilled water, its resistivity measured only 2650 ohm-cm.

Thus, when a subsurface pipe is installed, it would be in a trench backfilled with material of moderately high resistivity. However, when rain or other water enters these trenches, the backfill becomes low resistivity material. Also, water would remain in these backfilled trenches a long time, inviting corrosion.

The underground structures at generating stations usually are not completely isolated from foreign structures. In some cases there are numerous lead sheathed cables connecting the station to underground distribution systems. Continuity of the cable sheaths may be requisite for ground-fault clearing; for other reasons the insertion of insulating joints may be undesirable. Transmission line towers or pole grounds are connected to the station grounding system by the shield wires and counterpoise wires provided for lightning protection. However, the shield wires have appreciable resistance and generally only a few spans beyond the station affect the cathodic protection system. When foreign pipe lines entering a station are to be isolated electrically, the location for the insulated flange is selected to avoid hazard to personnel under fault conditions.

It is standard Ebasco practice to measure the earth resistivity to considerable depths at various locations at the sites of all new generating stations, in order that adequate bases may be obtained for designing suitable station grounds. From these measurements the need for corrosion mitigative measures may be determined prior to construction, and suitable coatings and cathodic protection can be incorporated in the overall design, if desirable.

The protective measures are planned to mitigate the greater part of the corrosion which otherwise would occur. In some parts of the underground network, corrosion although reduced may not be eliminated because the parts are electrically shielded by other structures. To attempt complete protection of all shielded structures is economically impracticable.

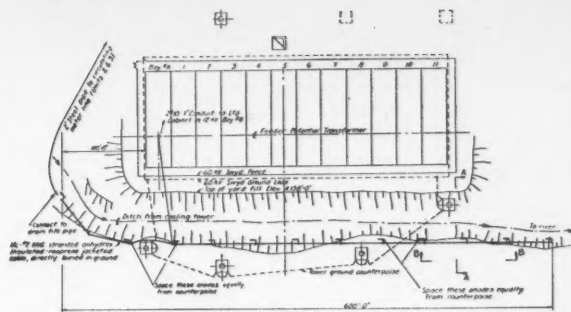


Figure 1

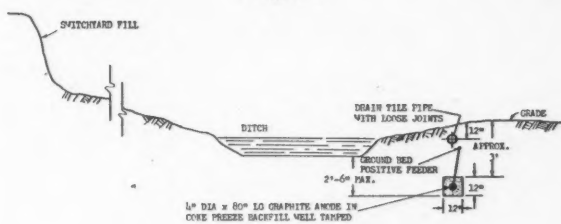


Figure 2—Sectional view of ground bed.

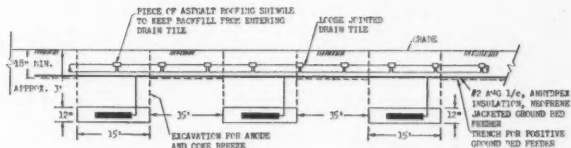


Figure 3—Longitudinal section of ground bed.

Current Requirements for Cathodic Protection

At twenty-four generating stations of 30,000 to 230,000 kw rating the current requirements for cathodic protection range from 25 to 200 amperes. In all of these cases the current is supplied by rectifiers in conjunction with ground-beds of graphite anodes.

Ground-Bed Locations

The desired conditions for a ground-bed location are: 1) Low resistivity soil with space available for the number of anodes required; 2) A ground-bed location some distance from underground structures and from foreign lines; 3) A d-c circuit of reasonable length permitting connection of the rectifier negative terminal to a substantial member of the station ground bus so there will be little I-R drop on the protected network.

A compromise is generally necessary in the choice of a ground-bed location. A ground-bed location remote from the station would provide fairly good current distribution, but larger currents would be collected on foreign lines entering the property and problems of coordination would be increased. A ground-bed location close to a structure may result in high current density on the particular structure, and lower current density on other structures.

At a steam electric station in Kansas, the soil structure comprised a layer of top soil of varying thickness, but seldom more than a few feet, a stratum of sand and gravel extending to roughly 40-ft. depth,

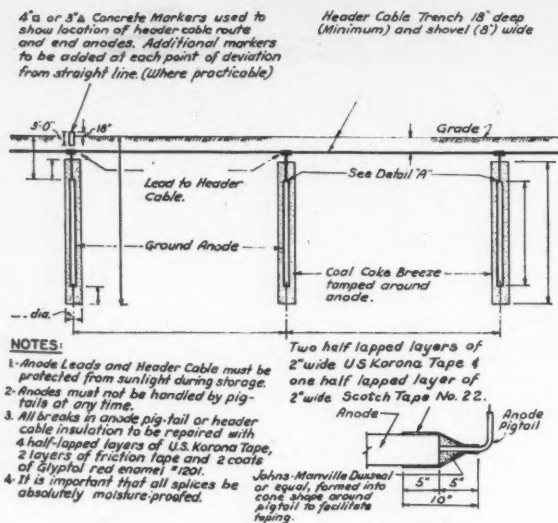


Figure 4—Typical vertical ground bed installation.

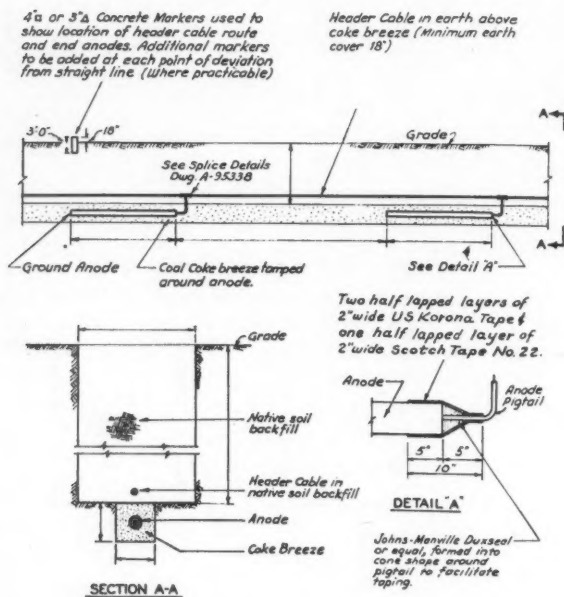


Figure 5—Typical horizontal ground bed installation.

with blue shale below the gravel. Considerable corrosion was found on many conduits which were excavated in connection with the 1948 extension to the plant. Most of these conduits were in the thin layer of low-resistivity top soil.

Ground-bed locations were quite limited because of the presence of high-resistivity sand close to the surface in most of the vacant areas. Consideration of the various factors involved indicated the most desirable ground-bed location to be south of the 60-kv switchyard in an old drainage ditch into which waste water from the cooling tower was discharged, as shown in Figure 1. This area had a top soil layer approximately 2 to 3 feet thick.

The ground bed was installed horizontally, as shown on Figures 2 and 3, close to the surface, with

loose-jointed drain tile immediately over the ground bed. This drain tile was supplied with high-conductivity cooling tower blow-down water from a ground bed watering pipe in order to maintain a low-resistance ground bed, after planned abandonment of the drainage ditch.

Counterpoise wires existed between the transmission towers south of the switchyard to the switchyard ground bus as a part of the lightning protection system for the transmission lines and switchyard. There was close coupling between the cathodic protection ground bed and these counterpoise wires due to the salted soil. The counterpoise wires were cut and it was found that the current collected by the counterpoise amounted to 8 amperes. The rectifier output is 30 amperes. Thus, if it had not been possible to cut gaps in the counterpoise wires, additional rectifier capacity would have been required.

Types of Ground Beds

Examples of construction of ground beds are shown in Figures 4 and 5. Either horizontal or vertical configuration is used, depending upon soil resistivity at various depths at the proposed ground-bed location, type of soil and construction equipment available.

In some instances where it has been possible to lower the ground bed into high-conductivity water, graphite anodes without backfill have been used. This reduces construction labor costs, but this is often largely offset by additional anode material cost, in order that reasonable anode life may be obtained. Additional weight of graphite anodes would be necessary because current is discharged directly into the water from the anodes. With a coke-breeze backfill around the anodes, the coke breeze is highly compacted and most of the current leaves the anodes by conduction to the coke. The graphite anode would be consumed only in proportion to the amount of current leaving the graphite rod by conduction to the soil water within the coke breeze. This is generally found to be small, and the major loss of material occurs in the coke breeze.

Installation of the usual type of ground bed would have been unsatisfactory at the station site previously described where caliche rock was present under a thin layer of top soil. The cathodic protection ground bed at this station consists of an abandoned well casing which was left in the earth for that purpose. Most of the current discharge from the casing ground-bed occurs below the 50-foot depth, because of the high soil resistivity above that level.

The distributed anode system has not been employed, because many areas are filled and unsuitable for anodes even if space requirements could be met in the congested areas.

Cathodic Protection Tests

The potential to remote earth of a simple structure under cathodic protection frequently may be used as a criterion of protection, particularly when shielding and proximity effects are small. Under these conditions when the potential of a steel structure is brought to -0.85 volts or more negative with respect to a remote copper-sulfate electrode, galvanic cur-

rents between anodic and cathodic areas with small mutual resistance are nullified.

Shielding and proximity effects are pronounced in generating station networks and the potential-to-remote-earth has limitations as a criterion of protection. Observations of potentials to close reference electrodes and of polarization effects are necessary also for determining results.

Testing is facilitated by use of a timing unit to interrupt the rectifier current periodically. A cycle of approximately 15 seconds "on" and 5 seconds "off" is satisfactory. The timing unit provides a continuous uniform timing cycle with definite indication of current on or off, which is more satisfactory than manual interruption.

One of the first requirements is the establishment of a remote reference electrode. A spare telephone pair is sometimes available as a lead to an electrode placed remote from the site. Another method of establishing a remote electrode is to measure potentials to an electrode moved away from the station in successive steps, while the rectifier output is being interrupted. Remote earth is reached when the change in potential becomes constant.

Figure 6 shows change in potential to a copper-sulfate electrode plotted against distance from a station site. There is first an increase as the position of the electrode approaches the ground bed, the electrode being about 100 feet from the ground bed at the peak of the curve. The potential change then decreased to a distance of 1100 feet after which it is practically constant. An electrode placed at some convenient point beyond 1100 feet from the station may be used for all tests to remote earth.

After the remote-earth electrode is established, potentials are measured at numerous parts of the network with the rectifier on and off.

The measurements of changes in potential constitute a check of the continuity of the grounding system. All structures solidly interconnected have the same change in potential except as modified by I-R drops in the network, and all will collect cathodic protection current. A lower than normal value for a structure in the network indicates an open ground cable, or need for a bond.

Because station structures are interconnected to form a more or less equipotential plane, current from the rectifier will cause the soil at the site to assume a negative potential with respect to remote earth. A structure not bonded to the protected network will follow the soil potential change but may discharge current at some point because of earth gradients. The areas of current discharge on such an isolated structure are evidenced by a positive change in potential to a close electrode, although the change in potential to the remote electrode is negative. If the condition exists the current is measured and bonds provided as required.

Long line galvanic currents, such as those due to switchyard grounding copper connected to steel piping or reinforcing, are largely eliminated when the potential to remote earth reaches -0.85 volts. Where galvanized structures are connected to copper grounding, a potential to remote electrode of -1.15 volts is required. Higher values are required in some cases

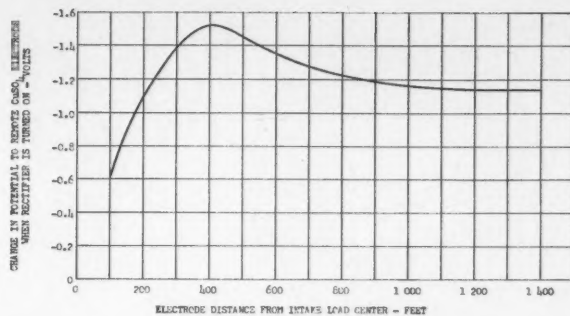


Figure 6—Curve showing relation between change of potential to remote copper sulfate reference electrode and electrode location as cathodic protection rectifier is interrupted.

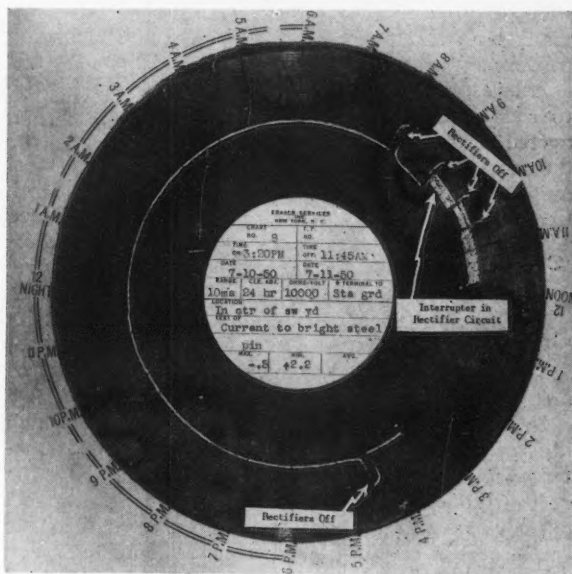


Figure 7

because of shielding and proximity effects. For the twenty-four installations previously mentioned, the potentials of protected structures to remote earth generally range from -1.0 to -1.5 volts although in an extreme case the potential was -3.1 volts.

The degree of protection is investigated by thorough survey of potentials and changes-in-potential measured to copper-sulfate electrodes placed close to various structures. Full protection is clearly indicated if potentials to close electrode are -0.85 volts for steel or -1.15 volts for galvanizing. It is noted at this point, that when current discharge in a galvanic cell has been halted by cathodic protection, the potential measured to an electrode close to the cathode is less than the open circuit potential of the anode, therefore, areas which were cathodic in the unprotected system do not have to be brought to -0.85 volts to a close electrode but such areas may not be readily identifiable. Consequently structures whose potential is less than -0.85 volts require further investigation.

If negative changes in potential to close electrodes are produced by the rectifier the structure being investigated is collecting current. Tests may then be

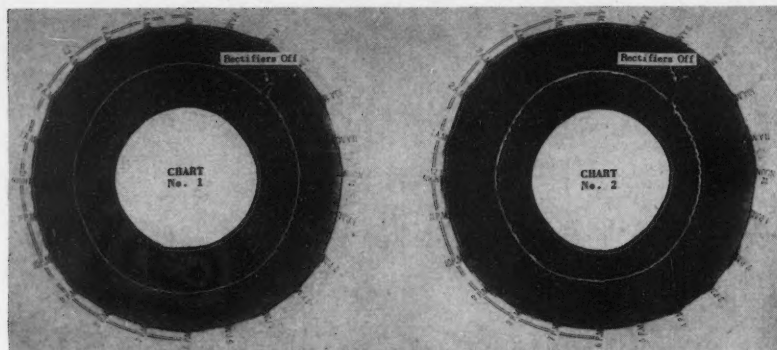


Figure 8

made with steel, zinc or lead electrodes according to the metal involved.

A bright steel pin is inserted into the earth close to a steel structure under investigation and connected through a milliammeter to simulate the condition of an anodic area on the structure. The steel pin discharges current when the rectifier is off. With the rectifier on, the current is reduced or reversed according to the degree of protection attained. Frequently the current discharge is not immediately reversed but over a period time, polarization produces a gradual decline in current discharge followed by collection of current.

The bright metal test may be misleading unless polarization is investigated.

In Figure 7 a recording chart is shown which illustrates the foregoing. The recording milliammeter with a 10 ma range was connected to show the current collected or discharged from a bright steel pin approximately one foot long inserted into the earth in the center of a switchyard. The positive meter terminal was connected to the station ground bus. Thus, a trace outside of the zero line indicates current discharged from the steel pin to earth and a trace inside the zero line indicates that the pin collects current.

The chart was started at 3:20 pm with the rectifier output 79 amperes. The rectifier was turned off for two ten-minute periods at 5:15 pm and 8:05 am. The current was increased to 92.5 amperes at 8:15 am and an interrupter was installed at 9:15 am. The output was reduced to 77.5 amperes for a 30-minute period starting at 10:05 am and subsequently increased to 97 amperes.

Comparison of charts 1 and 2 in Figure 8 shows the effect of shielding. The bright steel pin discharging current as shown on Chart 1 was located one foot from the side of a reinforced concrete manhole. A bright steel pin in the same general location but three feet from the shielding structures collected current as shown on Chart 2. The effect of the rectifier being "on" and "off" can be clearly seen on these charts.

As another example of shielding, piping in a sand fill between the concrete mat and finished floor of a station will not collect current from an external ground bed. Generally this is not serious, because sand is normally material of high specific resistivity

and little corrosion would be expected to occur in this environment when the sand remains dry.

Manholes in the cable duct system are constructed of reinforced concrete. Considerable shielding has been observed within the manholes because of the reinforcing. In manholes expected to be full of water, we have in some instances insulated bare copper neutrals and manhole grounding loops with vinyl tape. It is of particular importance that the sheath bond wires be formed so they leave the cables at a right angle. In manholes which usually contain severely corrosive water, it may be desirable to install galvanic anodes on the floor of the manholes for local protection of the cable sheaths.

Isolated Structures

Completely shielded or isolated structures such as intake screens, require separate cathodic protection systems. Screens are installed in the intake chambers to remove debris from the circulating water drawn from rivers or harbors. The usual installation in each chamber includes a trash rack of vertical bars at the entrance, a traveling screen made up of wire mesh panels linked in a vertical belt mounted on sprocket shafts and one or more fine screens made of wire mesh panels supported in rectangular frames. The screen units extend from the deck to the bottom of the chambers which are from six to ten feet wide and of various depths. The structural members are steel and in some cases the entire structure is galvanized. Bronze, copper and galvanized mesh are used, the former more frequently in salt water.

Trash racks are cleared with rakes or scrapers and are removed only for painting or repairs. Traveling screens are rotated intermittently for washing away debris with water jets. Fine screens are hoisted out of the chambers for cleaning.

Many original screen installations consisted of steel frames with galvanized screen mesh. In corrosive waters this caused rapid disintegration of the screen panels and led to replacement with bronze or copper mesh. The framework then became anodic to the mesh. Corrosion is severe in salt water and it is not uncommon to replace fine screen sections, or to make extensive repairs to traveling screen panels and framework after two or three years' operation. In fresh water corrosion is less severe but in many cases is sufficient to warrant remedial measures.

The screens are in contact with reinforcing steel in the intake structures and the traveling screens may be bonded to the station grounding system. The large galvanic cells thus formed increase the corrosion on the screens. Bronze or copper mesh likewise cause damage to screen panel frames and structural members.

Cathodic protection applied to a station grounding system changes the potential of the screens to remote earth and overcomes the effect of the grounding copper but shielding by the reinforcing steel precludes protection from distant ground beds.

Current requirements for various installations in depths 8 to 18 feet are of the order of 10 to 60 amperes per chamber in sea water. Corroded screens and screens with copper mesh require more current than new galvanized structures. The velocity of the water, partial shielding of parts of the structures and the removal of the screens from the water for cleaning retard uniform continuous polarization. This makes the current requirement larger than that of an equivalent area of metal in still water.

Rectifiers and graphite anodes specially treated for use in salt water are generally used in the installations discussed. The rectifiers are mounted near the intake chamber.

Figure 9 shows a type of anode installation which has been employed at several stations using sea water. Six to fourteen anodes are used in each chamber, for water depths ranging from 8 to 18 feet. The anodes are placed horizontally in the spaces between the trash rack, traveling screen and fine screen and inside the traveling screen. The anodes are placed in trays made of creosoted lumber or Transite pipe sawed longitudinally, supported by two pipes suspended from a cross piece above the water level and restrained at the lower ends. Each pair of pipes supports two or more trays and may be withdrawn for inspecting the anodes. The bottom tray is not closer than 3 feet from the bottom of the chamber. Anode leads are brought up through the hanger pipes and the latter are cathodically protected.

Installation of anodes on the downstream side of the fine screen is usually avoided to avert the possibility of broken anodes or trays reaching the circulating water pumps. However, several installations on the downstream side were so placed because of insufficient spacing between the fine screens for anode trays and have been operating without trouble for about three years.

Anodes are placed inside the traveling screen because the structural frame and the backs of the screen panels are shielded from the anodes outside.

Bonds are necessary across the pin and link joints used where fine screens and trash racks are built in two or more sections. Traveling screens require flexible bonds between screen panels and a bond between screen belt and frame when there is contact resistance between the parts. The bond from screen belt to frame must permit ready removal and reattachment at washing periods.

The leads from each structure and each group of anodes are brought up to a connection block in order that resistance may be installed to adjust current distribution.

Potentials are measured to electrodes which are tied in place when the screens are raised, or lowered into the water and carried to the metal by the water flow, or otherwise placed at the desired spots. The electrode is placed against the metal for comparable observations on various parts of the structures; a separation of a few inches between electrode and metal introduces I-R drops, even in sea water.

A thorough exploration of potentials is made in areas accessible for measurement. Currents are adjusted to produce potentials of -0.90 volts to -1.0 volts for steel, and -1.2 volts for galvanizing which

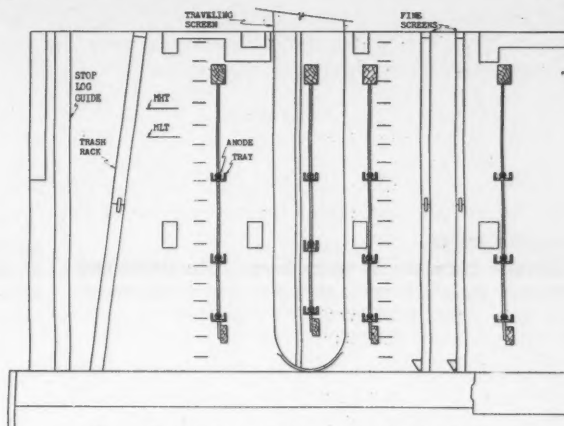


Figure 9—Anode installation in intake chamber.

allows some margin for shielded areas not accessible for measurement. Potentials of traveling screen sections and fine screens drop off after washing, but when polarization of the fixed parts is well established the potentials tend to be restored rapidly.

Calcareous films from sea water form slowly, but generally the greater part of the metal ultimately becomes coated. Screen structures are not well adapted to formation of a uniform and satisfactory calcareous film by short time application of a large current because of self shielding, water velocity and washing. Furthermore, the application of a heavy current for an extended period may affect reinforced concrete. Potential measurements are the criterion of protection, rather than current density.

The anode grouping described provides close coupling of anodes to the structure to minimize loss of current to the station grounding system and reinforcing steel. Excess stray current on reinforcing steel is undesirable, because it could reduce the bond to the steel in current collecting areas if the current density were sufficiently high. Current discharge from the steel would produce rust which could develop sufficient pressure to crack concrete, but this condition will not exist when the stray current is drained off by accidental contacts with screen guides or anchor bolts or by a bond if such contacts are absent.

Spillway gates at one of the stations required a separate cathodic protection installation. Protection was installed to eliminate the necessity of painting the water side of the gates. These gates were normally painted at two year intervals. At these times it was found necessary to do considerable scraping and repriming of the steel surfaces, because of the large number of rust spots, pits, and tubercles. The small areas of steel exposed at holidays are anodic to reinforcing steel in the dam.

The cathodic protection installation comprises a ground bed of graphite anodes in vertically augered holes, backfilled with coke breeze, located on the side of the dam. The heavy chains supporting the gates do not form an effective low resistance link between the operating mechanism and the spillway gates and bonds are installed.

Potentials are kept below 1 volt to close copper

sulfate electrode in order to prevent damage to the paint film. The potential to remote copper sulfate electrode is approximately —1.5 volts.

Condensers

The usual type of condenser at a generating station consists of copper-alloy tubes and tube-sheets housed in a cylindrical steel shell at the ends of which are fitted cast-iron water boxes that direct the flow of cooling water.

Galvanic corrosion of water boxes, tube sheets and tube ends may present a problem where sea water or aggressive fresh water is used for cooling in addition to conditions associated with water flow. Paint coatings of various kinds are used in water boxes and galvanic anodes have been installed in some instances. There is not much data available on certain features of galvanic corrosion and protection, such as the changes which take place as graphitization of the cast iron progresses, or the application and effectiveness of cathodic protection. Another matter is the desirability of electrically isolating the water boxes from the shells where sea water is circulated. Some slight modifications in the present design of condensers would be necessary to permit ready isolation of water boxes.

A test proposed by M. C. Miller of Ebasco Services, Inc., is being carried out, through the cooperation of a public utility, on the condensers of a 40,000 kw unit and two 12,500 kw units at a generating station where sea water is used for cooling. Insulating tubes and washers were installed on the bolts holding the water boxes to the shells when the condensers were assembled. The insulated bolts and the standard rubber gaskets isolate the water boxes from the shells and copper-alloy tubes. Flange insulation was installed in drain lines and priming lines connected to the water boxes.

The 12,500 kw units have been in service about two years. During this time one condenser has been operated with the water boxes isolated and the other with short-circuiting bonds between the shell and the water boxes. The 40,000 kw condenser, in service about 17 months was operated for six months with the water boxes isolated, after which period magnesium anodes were installed. The initial values of galvanic open-circuit potential and short-circuit current between the water box and shell of the large condenser were of the order of 0.5-volt and 10-amperes, respectively.

Periodic observations are made of galvanic potentials and currents of the three condensers and the water boxes are examined when station operations permit inspection. The periodic measurements and inspection results are not presented here because the test is not complete. However, it may be noted that after one year of operation of the 12,500 kw condenser fitted with short-circuiting bonds, the water boxes had developed considerable graphitization. The galvanic potential and short-circuit current of this unit have decreased to a degree that a reversal by the end of the second year is anticipated. The open-circuited unit during the same period exhibited only a small amount of graphitization and small change in open-circuit potential and short-circuit current. The

test is being continued and is expected to furnish information of value in regard to several phases of the problem.

Recent Developments

Since one of the large sources of corrosion at generating stations is the interconnection of steel and lead structures with the copper grounding system, it would appear desirable to eliminate this large copper cathode if possible. To accomplish this it frequently is recommended that tinned copper, which also is effective in reducing the current requirements for cathodic protection, be used.

With cathodic protection it is not necessary to encase all duct banks in concrete. Individual runs of galvanized conduit directly buried in the soil can be used.

Welded steel pipe with a minimum coating has advantages over cast iron with leaded joints, because it is electrically continuous and can be protected economically. In many cases material can be saved because it is not necessary to allow additional pipe wall for corrosion damage.

Results and Conclusions

That cathodic protection is an effective method of reducing the cost of corrosion at generating stations is borne out by the fact that where properly designed, installed and operated it has halted or substantially reduced underground corrosion.

At one station the transformer oil piping was placed above ground, due to corrosion leaks and several failures occurred in lead covered cables. Subsequent installation of cathodic protection of the underground network was successful and no additional leaks or failures have been reported after approximately two and one-half years operation.

At another station built alongside an older plant cathodic protection was installed when the station was built nearly three years ago. Recent excavations in connection with a new extension have shown no signs of corrosion on the underground system. Corrosion would have been expected without cathodic protection, because it was experienced at the older plant.

Painting of the water-side of the spillway gates previously mentioned has been discontinued. At the last inspection, one small rust spot could be found on one gate opened for inspection after the cathodic protection system was in operation for approximately two and one-half years. About six months had elapsed between the last painting and installation of the cathodic protection system. Without cathodic protection this gate would have been covered with rust spots, as determined from experience prior to the installation of cathodic protection.

Cathodic protection of intake screens in fresh water shows satisfactory results. Installations in service for one and one-half to two and one-half years at six generating stations which use sea water for condensing purposes have maintained new screens in good condition and have halted corrosion on older equipment. Results are apparent to visual inspection. Accumulation of barnacles on the screen units has been greatly reduced at two stations where they had been troublesome.

A Flow Control Device For Gravity-Feed Lubricators*

By J. A. CALDWELL*

THE INJECTION of suitable chemicals into gas-condensate wells has become a widely used method of corrosion control in such systems. Because many gas-condensate wells produce water which is relatively low in total solids, a water solution of a neutralizing agent such as soda ash or an inorganic inhibitor such as sodium dichromate can often be used without causing the formation of troublesome precipitates in the tubing. If the tubing in the well is hanging free or if it is perforated above a packer, such a water solution can be injected through the casing wing valve so that it goes to the bottom of the well and returns up the tubing to the surface mixed with the well fluids. Injection of the solution can be accomplished by the use of a power-driven pump or a gravity-feed lubricator.

The gravity-feed lubricator is notable for its simplicity and lack of service problems. One of its disadvantages is that the rate of flow of a liquid from it is difficult to control by means of a throttling valve. However, this difficulty can be overcome by use of the choke illustrated in detail in Figure 1 and shown in Figure 2. The choke consists of a stainless steel tube $\frac{1}{16}$ inch ID and about 8 feet long wound in the form of a coil and installed in a suitably modified O-C-T Type FC-140 flow bean. This choke will deliver about 7.5 gallons of a dilute solution of soda ash (1 lb. Na_2CO_3 per gallon of water) per 24 hours from a lubricator with an average liquid head of

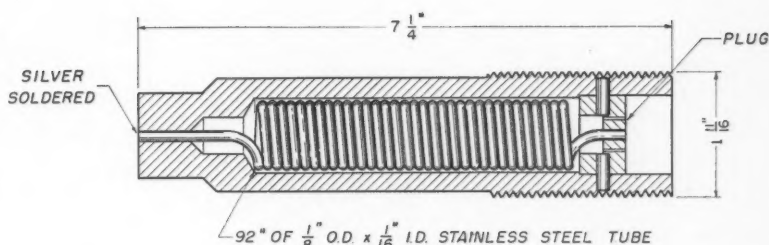


Figure 1—Choke for inhibitor injection.

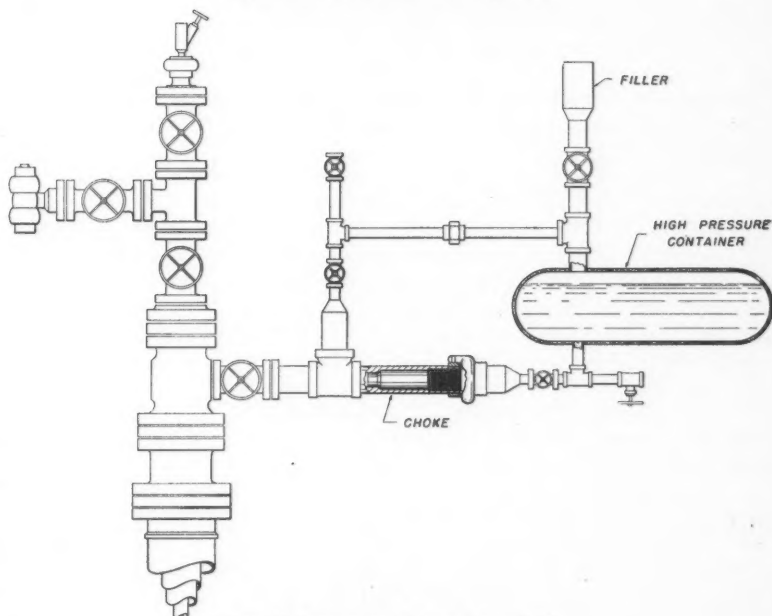


Figure 2—Gravity feed lubricator assembly.

2.5 feet above the choke. Chokes of this type have been used successfully since 1946 to control the rate of injection of water solutions of sodium carbonate, potassium carbonate and sodium dichromate into some thirty gas-condensate wells in the Katy field. For some chokes the length of the tubing has been reduced below that shown in the sketch in order to permit higher rates of flow.

*Submitted for publication June 3, 1952.
*Humble Oil & Refining Co., Houston, Texas.



Discussions

Some Observations of the Potentials of Stainless Steels in Flowing Sea Water by K. M. Huston and R. B. Teel. *Corrosion*, Vol. 8, No. 7, 251-256 (1952) July.

Question by Norman Hackerman, University of Texas, Austin:

Is this potential order really useful in other aqueous solutions?

Reply by K. M. Huston:

Yes, the galvanic series of stainless steels in flowing sea water may be used as a guide in predicting galvanic relationships in other aqueous solutions. The paper as presented is an abbreviated version of the paper as prepared. The paper reports that while the potential values may change with different electrolytes under different conditions as to aeration, flow, temperature, corrosion, etc., the relation of one alloy to another in any one electrolyte should follow this pattern. It should be realized that some conditions will exist where the maximum or minimum potential values will control. Under these conditions galvanic corrosion will be either accelerated or retarded to a greater degree.

Corrosion by Fluorine and Fluorine Compounds by Ralph Landau. *Corrosion*, Vol. 8, No. 8, 283-288 (1952) Aug.

Question by E. N. Skinner, Jr., International Nickel Co., New York, N. Y.:

The author has referred to the increased susceptibility to corrosion by fluorine exhibited by Type 347 stainless steel, which is presumably due to the formation of a volatile columbium fluoride. In this respect, it would be of interest to know whether evidence has been obtained of similarly impaired corrosion resistance for Type 321 stainless or for any of the unstabilized grades specifically containing an intergranular precipitate of chromium carbide.

Reply by Ralph Landau:

We have no information on this point.

Question by Hugh P. Godard, Aluminium Laboratories, Ltd., Kingston, Ontario:

What silicon content can be tolerated in aluminum without adversely affecting its corrosion resistance to fluorine?

Reply by Ralph Landau:

We have no data.

Question by H. Howard Bennett, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:

Have you experienced preferential attack at the

welds on carbon steel handling HF acid of 90 percent concentration? If so what is the cause of this type of attack?

Reply by Ralph Landau:

This has not happened in our experience.

Question by Wayne Z. Friend, International Nickel Co. Inc., New York, N. Y.:

The author stated that small amounts of silicon in stainless steels decrease the resistance of these alloys to fluorine. Most of the authentic stainless have a silicon specification of 1.0 percent maximum. In the author's experience will differences in silicon content within this range, such as between 0.25 percent and 0.75 percent have a definite reproducible effect on resistance of an alloy such as Type 304 or 316 stainless? If so, is the attack general or pitting?

Reply by Ralph Landau:

We have had insufficient experience to express results in so quantitative a form, as most of our tests were made as installed.

An Improved Electrolysis Switch by V. B. Pike. *Corrosion*, Vol. 8, No. 9, 311-313 (1952) Sept.

Discussion by H. G. Burd, Ansonia Electrical Company, Ansonia, Conn.:

How do you maintain the cable sheath bond through vibration and other similar conditions?

The question resulted from a perspective on the need of electrolysis counteraction. Since bonding of lead sheath to lead sheath and to ground is of vital importance in maintaining drainage of stray currents (as well as cathodic protection), isn't it difficult and expensive to really maintain these bonds month by month and year by year? The writer knows, for example, that the City of Seattle had a rather serious earthquake three or four years ago and the city fire alarm superintendent stated that practically all of the bonds were broken and hence cables were going out of service right and left due to electrolysis—and that it would take a large sum of money and time of many men to reestablish all the bonds.

Secondly, in heavy traffic streets the vibration is considerable and unless bonds are very well made in the beginning and kept in good condition by a large available field organization (such as Bell Telephone has) obviously the bonding can easily become imperfect and electrolysis occur in greater degree than would otherwise.

Is not the solution therefore in many cases to use non-lead sheath cable which will not have the electrolysis and corrosive feature?

Since quite apparently the theme of both papers No. 18 and No. 19 covers methods to prevent or counteract stray current corrosion of lead sheathing

on cables (as well as other structures perhaps), a very logical reaction could be as to why, in future planning, and with lead anticipated by authorities to be short in supply in the long run over the next several years, can planning be done to install non-lead sheath cable wherever possible? The large electric light and power utilities very frequently get into lead sheath corrosion difficulties and either go to non-lead neoprene or plastic jacketed cables, or sometimes reduce the thickness of lead sheathing to say two-thirds normal wall and put a jacket over the lead. The latter is a costly procedure, involves two operations, first of lead covering and then of later jacketing over the lead, hence a more costly cable.

For network services the electric light and utilities have gone very largely to rubber plus neoprene jacket—hence without lead. Bell Telephone, probably because of an anticipated short supply of lead over years to come, started to make "Alpeth" cable a number of years ago.

Is it not therefore smart and alert practice for engineers to go to non-lead cable except in very heavy duty power cable where the insulation is oil impregnated paper and a lead jacket is still almost a "must?"

If an economic study could be made of all of the expense applied to counteract underground corrosion of lead cable and the reduced maintenance and troubles with non-lead cable, would not future engineering design trend decidedly away from lead?

Author's Reply:

Maintenance of the continuity of cable to cable or cable to ground bond wires because of vibration and physical stress has not been a problem in the Bell System. Although there are instances where

this type of breakage has occurred, routine observation of the plant for other reasons is normally frequent enough that bonds are repaired before complete breakdown occurs or so soon after failure that the plant loss resulting from electrolysis from this cause is of minimum consequence. When major disturbances occur such as fires, cave-ins, earthquakes, etc., our maintenance forces are usually on the scene because of other needs of plant maintenance. Damage to electrolysis bonds are quickly reported to the electrolysis personnel and repaired without lengthy periods of outage. In addition, co-operation with maintenance forces of other companies is striven for and information from them concerning possible injury to our plant is beneficial and appreciated.

Construction methods are designed to produce maximum reliability in the plant at least cost commensurate with maximum overall economy. When new methods or new materials become available the plant procedures are modified to take advantage of them as soon as possible.

For several years the Bell System has used a type of cable covering referred to as "corrosion protected." This cable has a covering of paper and jute impregnated with asphalt wrapped over lead sheath and is corrosion resistant.

About two years ago additional types, namely, Alpeth, Stalpeth and polyethylene jacketed coverings were approved. Alpeth has polyethylene extruded over corrugated thin sheet aluminum formed about the cable core and Stalpeth has polyethylene extruded over corrugated thin sheet steel hermetically closed on the core. Alpeth and Stalpeth coverings are being used on exchange cables. Polyethylene jacketed cable has polyethylene extruded over thin lead sheath and is used in toll cable construction.

You can't stop a gusher with a bottle cap



You can't stop corrosion
with ordinary paints . . .

it takes

BITUMASTIC COATINGS!

CORROSION can't be stopped by ordinary paints or conventional protective coatings. They can't protect surfaces against the ravages of rust for any appreciable length of time.

But Bitumastic Coatings can!

Unlike maintenance paints, Bitumastic® Protective Coatings are specially formulated from a base* of coal-tar pitch that is, for all practical purposes, impervious to water. When you keep moisture away from an exposed surface, you stop corrosion.

Bitumastic Coatings provide an extra-tough, extra-thick barrier against corrosive elements—a barrier that is impenetrable. And these coatings provide up to 8 times the film thickness of conventional paint coatings.

Bitumastic Coatings stop corrosion caused by moisture—acid fumes—alkaline fumes—corrosive soil—salt air—heat.

*Hi-Heat Gray contains a metallic base.

There are 6 Koppers Coatings—formulated to control corrosion of metal and deterioration of concrete. Use the coupon for full information.

SEND FOR SET OF FREE BOOKLETS!

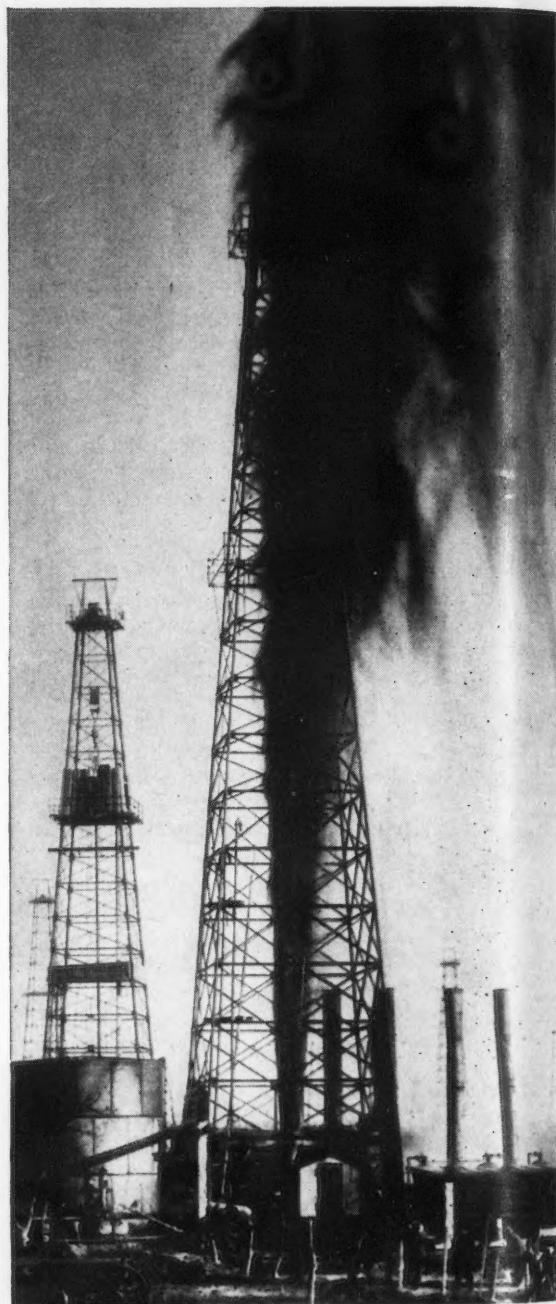
Koppers Company, Inc., Tar Products Division
Dept. 904-T, Pittsburgh 19, Pa.

Please send me, without charge or obligation, your booklets on corrosion prevention.

Name.....

Address.....

City.....Zone.....State.....



BITUMASTIC PROTECTIVE COATINGS

REG. U.S. PAT. OFF.

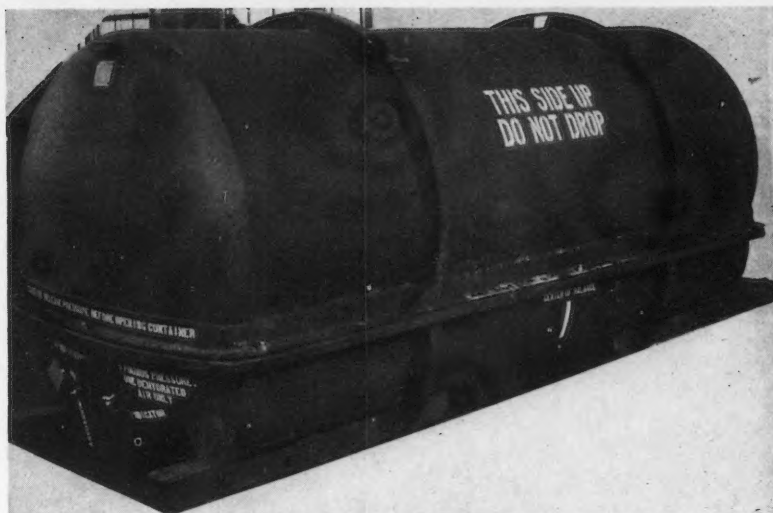
SOLD THROUGH
INDUSTRIAL
DISTRIBUTORS

KOPPERS COMPANY, INC., Tar Products Division, Dept. 904-T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

Topic of the Month

All-Metal container for jet engines cuts maintenance.



All-Metal Containers Replace Wooden Ones For Aircraft Engines *

THEY'RE PUTTING U. S. Air Force airplane engines into "cans"—and saving American taxpayers millions of dollars annually. All-metal containers are replacing the wooden ones used to store and ship the engines, giving far more protection against accidental damage and eliminating the frequent inspections formerly needed to guard against rust and corrosion.

The containers were developed to military specifications by various manufacturers. Testing has continued for three years at the Power Plant Laboratory, Aeronautics Division, Wright Air Development Center, an installation of Air Research and Development Command, Wright-Patterson Air Force Base. A standardization program is underway to select one design for each engine type, except where engine mountings are the same in which case the same type of container can be used. It is expected that about 10 standard designs will cover all major engines.

Though the average original cost of a metal container is about \$20 more than a wooden one, it is estimated that \$6,634,000 can be saved annually, solely on the preservation of spare engines through storage in the "cans." Engines so protected can stand one year with only occasional inspection. Under the old method, frequent inspections were necessary.

Two styles of containers are in production. The first, usually used for smaller engines, permits them

to be stored with the longitudinal axis in a vertical position. The second, used for jets and the bigger reciprocating engines, mounts them in a horizontal plane.

The containers are made of 11- or 12-gage low-carbon, hot-rolled steel plate. Two rolled steel flanges combine with the wrapper plate and a rubber "O" ring to give a three-point moisture and air seal. Designed for handling by fork-lift trucks, the containers weigh about the same as the small engines, only two-thirds as much as the bigger ones.

As part of the moisture barrier, five pounds of dehydrated air is pumped into each container. A service receptacle contains the air admittance valve, a relief valve, and a humidity indicator. This receptacle simplifies the replacing of the desiccant whenever needed. When wooden boxes were used, it was necessary to open them completely to replace the desiccant. Also on each container is a cylinder which holds the engine's records and installation instructions.

There is no metal-to-metal contact between the engines and the containers. The engines are mounted on either biscuit- or tubular-type rubber mounts. Tests show that no damage results when one end of a container is dropped 36 inches. As another part of the tests, the containers are rolled completely over. They also are immersed in water.

Plates on top of each permit the containers to be stacked three high.

* Reprinted from Technical Data Digest, Page 12, Sept., 1951.



NACE News

Rogers, Wachter, Brannon, Nominated for Offices



WALTER F. ROGERS
Gulf Oil Corporation, Houston



AARON WACHTER
Shell Development Co., Emeryville, Cal.



RUSSELL A. BRANNON
Humble Pipe Line Co., Houston

Committee Also Names Three for Directorships

Walter F. Rogers, Gulf Oil Corp., Houston has been nominated for the presidency of the National Association of Corrosion Engineers by the NACE Nominating Committee. Mr. Rogers is now vice president. Aaron Wachter, Shell Development Co., Emeryville, Cal. has been nominated for the vice-presidency and Russell A. Brannon, Humble Pipe Line Co., Houston, to succeed himself as treasurer.

Nominated for directorships were J. Pat Casey, Jr., The Crane Co., Chicago, as a director representing corporate membership and W. F. Fair, Jr., Koppers Co., Westfield, N. J. and Robert L. Bullock, Interstate Oil Pipe Line Co., Shreveport, La. as directors representing active membership.

The report of the nominating committee will be mailed officially to the membership on or before September 1, and members have until October 4 to prepare and file nominations by petition.

All Active in NACE

All nominees have been active in the association, some since its inception. Mr. Rogers was general chairman for the Galveston Conference and Mr. Wachter not only has contributed technical material to the association, served as chairman of technical symposia, but also has been active in the Western Region's phenomenal growth. Mr. Brannon has been active in association affairs and is

a member of technical committees, as are the other nominees.

Mr. Casey was chairman of Chicago Section in 1950 and has been active at national meetings. Mr. Fair, 1951 chairman of Metropolitan New York Section also has been a lecturer at NACE-sponsored short courses and active in the association otherwise. Mr. Bullock is among the more active members of technical committees in the petroleum field and recently was named chairman of TP-18A on Internal Sour Crude Corrosion of Pipe Lines and Tanks. He was Technical Program Chairman for the Galveston Conference.

Schedule of Events

The following schedule of events related to the election of national NACE officers is set by the articles of organization and by-laws: (All dates are completion dates.)

Formation of Nominating Committee—March 11, 1952.

Nomination of candidates and report to the executive secretary—July 15, 1952.

Preparation and mailing of nominating committee report to NACE members—September 1, 1952.

Time provided for members to prepare and file nominations by petition—October 4, 1952.

Preparation and mailing of letter ballots to NACE members—November 1, 1952.

Period allowed for return of letter ballots—December 20, 1952.

Period allowed to count ballots and prepare tellers' report—January 10, 1953.

General business meeting—March 17, 1952.



NACE MEETINGS CALENDAR

Sept.

8—North Texas Section.

24—San Francisco Bay Area Section. C. L. Bulow, Corrosion Metallurgist, The Bridgeport Brass Co., Bridgeport, Conn., will speak on "Corrosion Testing of Condenser Tubing."

29—Tulsa Section. Norman T. Shideler, Pittsburgh Coke & Chemical Co., will speak on the specifications of pipe coatings from the manufacturers' and consumers' points of view.

Nov.

19—San Francisco Bay Area Section. The International Nickel Co. film "Corrosion in Action."

NACE Membership in Canada Up 40 Percent

An increase of more than 40 percent in membership of NACE has been registered in Canada since February 15. The addition of 21 members brings membership of Canadians in the association to 72 up to the middle of July.

Discussion continues on the organization of local subdivisions among Canadian members and formal organized affiliation of a Canadian organization with the NACE.

Pittsburgh Section Names New Officers

New officers of Pittsburgh Section have taken up their duties for the 1952-1953 term as follows:

N. P. Peifer, Manufacturers Light and Heat Co., chairman; N. T. Shideler, Pittsburgh Coke and Chemical Co., vice-chairman; F. E. Costanzo, Manufacturers Light and Heat Co., secretary and W. W. Binger, Aluminum Company of America Research Laboratories, treasurer.

Mr. Binger's offices are at New Kensington and all the others are at Pittsburgh.

Detrick Elected Head Of Cleveland Section

New officers for 1952-53 have been elected by Cleveland Section. Taking office at once were C. N. Detrick, Williams & Co., Inc., chairman; W. E. Baker, Standard Oil Co. of Ohio, vice-chairman and H. W. Hosford, Jr., Harco Corporation, secretary-treasurer. All are of Cleveland.

An advisory council was named also as follows: T. S. Howald, W. W. Palmquist, S. M. Seidman and R. C. Weast.

Southwestern Ohio Headed by McDuffie

Roy O. McDuffie, of the University of Cincinnati has been elected chairman of Southwestern Ohio Section NACE. Other officers elected were Arthur D. Caster, City of Cincinnati, vice-chairman and Lewis M. Lederer, Inner-Tank Lining Corp., Cincinnati, reelected secretary.

Because of a tie vote the treasurer will be named by the sections board of directors.

Subcommittee Heads Named for TP-18

New subdivisions of Technical Practices Committee 18 on Internal Corrosion of Facilities for Storage and Transportation of Petroleum have been formed. They are:

TP-18A—Internal Sour Crude Corrosion of Pipe Lines and Tanks. R. L. Bullock, Interstate Oil Pipe Line Co., Shreveport, La., chairman.

TP-18B—Internal Corrosion of Products Pipe Lines. Ivy M. Parker, Plantation Pipe Line Co., Bremen, Ga., chairman.

Hayward Heads TP-14

H. N. Hayward, with the Engineering Experiment Station, University of Illinois, Urbana, Ill., has accepted chairmanship of Technical Practices Committee 14—Instruments for Corrosion Measurements.

The 1953 annual NACE meeting will be held in Chicago, March 16-20.

Western Region Plans Conference for November 20-21 on "New Techniques"

Western Region has scheduled a regional corrosion conference for November 20 and 21. Tentatively, the theme of the meeting will be "New Techniques in Corrosion Research," but Austin Joy is open to suggestions on this point. These and several other decisions were made by the region's board of trustees at a July 11 meeting at Los Angeles.

Decisions concerning the meeting were made as follows:

No official luncheon will be provided on the 20th, but arrangements will be made for tables accommodating 6 to 10 at lunch.

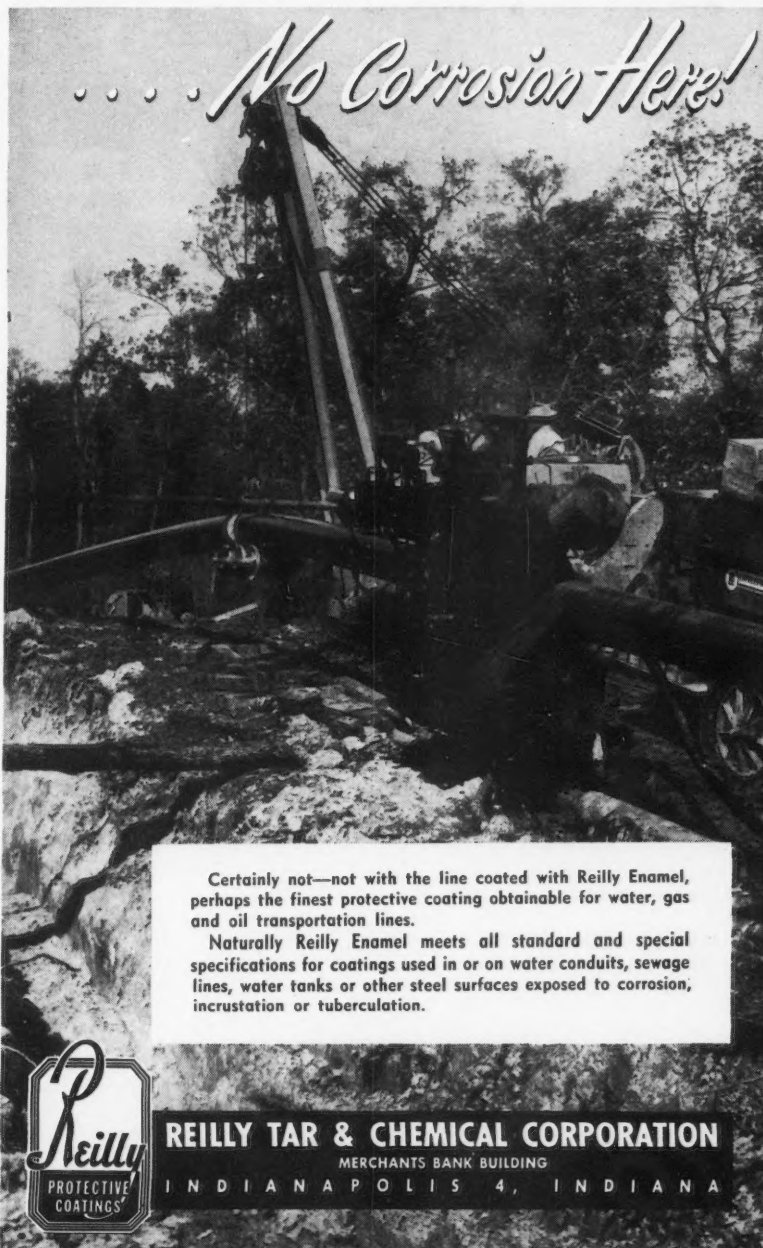
No technical speaker will be heard at the 20th luncheon but some entertainment may be provided.

A dinner meeting with speaker will be held on the evening of the 20th. An informal luncheon will be held on the 21st.

Announcements will be sent out to section heads concerning the meeting.

There will be no scheduled field trips and no exhibits.

The 1952 Annual Directory of Membership was published in the March, 1952, issue of Corrosion.



No Corrosion Here!

Certainly not—not with the line coated with Reilly Enamel, perhaps the finest protective coating obtainable for water, gas and oil transportation lines.

Naturally Reilly Enamel meets all standard and special specifications for coatings used in or on water conduits, sewage lines, water tanks or other steel surfaces exposed to corrosion, incrustation or tuberculation.

REILLY
PROTECTIVE COATINGS

REILLY TAR & CHEMICAL CORPORATION
MERCHANTS BANK BUILDING
INDIANAPOLIS 4, INDIANA

For textile mills,
steel mills and
chemical plants...

LEADING ENGINEERS

CHOOSE SARAN RUBBER*

LINED PIPE!

To solve pipeline corrosion, MICHIGAN SARAN RUBBER-LINED STEEL PIPE offers the highest degree of resistance to corrosive chemicals, oils, acids and gases. Available in either fabricated light gauge steel or standard steel pipe in regular 10' and 20' lengths ranging in size from 8" up...or fabricated to your exact requirements.

For additional information write to your MPC representative or to our Application Engineering Dept.

*Saran Rubber is a development of the Dow Chemical Company



Co-Chairmen for Seven Events in Chicago Meeting Technical Program Are Named

Annual Shreveport Short Course Will Be Held September 18-19

Shreveport Section's third annual Corrosion Control Short Course has been scheduled to be held Thursday and Friday, September 18 and 19. Registration will open at 8 a.m. on the eighteenth at the Centenary College Science Building, Shreveport. Registration fee is \$10, and includes a noon meal Thursday, a banquet Thursday evening and a noon meal Friday.

The program is designed to benefit all engaged in pipe line or production work by explaining the fundamental principles of corrosion and presenting methods used to combat it.

Inquiries for additional information should be addressed to R. V. Jordan, P. O. Box 1407, Shreveport, La.

The program was announced as follows:

Thursday, September 18

8:00 a.m.—Registration, Science Building, Centenary College.

9:00 a.m.—Introduction and welcoming remarks.

10:00 a.m.—Motion picture on corrosion.

12:30 a.m.—Luncheon, Centenary College Cafeteria.

Fundamentals of Corrosion Control
1:30 p.m.—Fundamental corrosion theories and review of methods of combating corrosion.

Concurrent session for engineers and others with considerable experience—"Knotty Problems" Round Table Discussion.

2:30 p.m.—Cathodic protection.

3:30 p.m.—Protective coatings.

5:30 p.m.—Fellowship Hour.

6:30 p.m.—Banquet.

Friday, September 19

Field Testing, Maintenance and Operation

8:00 a.m.—Instruments for field testing and testing procedures.

10:00 a.m.—Better results through improved operation.

11:00 a.m.—Improving field maintenance.

12:30 a.m.—Lunch at Centenary College cafeteria.

Production Corrosion Problems

1:30 p.m.—Evaluating internal corrosion

3:00 p.m.—Other methods of corrosion evaluation.

Two Changes Are Made In TP-5 Officials

Changes of officers in Technical Practices Committee 5 on Corrosion Problems Involved in Processing and Handling Chemicals have been made as follows:

Paul J. Gegner, Columbia-Southern Chemical Corp., Barberton, Ohio has been named vice-chairman of TP-5.

C. F. Pogacar, Atlantic Refining Co., Philadelphia, has been named chairman of TP-5C on Subsurface Corrosion by Alkaline Solutions.

Co-chairmen for six symposia and one round table session at the 1953 Conference in Chicago have been named. They are:

High Temperature—G. A. Fritzen, Haynes-Stellite Co., Kokomo, Ind.

Protective Coatings—N. K. Senatroff, Southern Counties Gas Co. of Cal., Los Angeles, Cal.

Oil and Gas—R. C. Buchan, Humble Oil & Ref. Co., Houston.

Chemical—E. G. Holmberg, Alloy Steel Products Co., Linden, N. J., and G. F. Lockeman, Procter & Gamble, Cincinnati.

Water—S. T. Powell, Baltimore, Md.

Electrical and Communications—W. D. Sanderson, Detroit Edison Co., Detroit, and R. M. Lawall, American Telephone and Telegraph Co., Cleveland.

General Corrosion Round Table—L. E. Stout, Washington University, St. Louis.

Papers are still being solicited for the various symposia. Inquiries or correspondence should be addressed to the responsible symposium chairman, names of whom will be found in August Corrosion on Page 3, News Section.

South Central Meeting Pipe Liner's Forum Set

Two informal sessions of a "Pipe Liner's Forum" will be held morning and afternoon October 2 during the South Central Region's meeting at New Orleans. A panel of field engineers will sit at each session to answer questions from the floor as required. L. G. Sharpe, Senior Corrosion Engineer for Humble Pipe Line Co., Houston, general forum chairman, said names of panel members will be given in the official program of the meeting.

Questions and topics are expected to include the full range of pipe line corrosion problems from construction to dismantling.

78 Plan to Exhibit

Seventy-eight firms have signified their intention of exhibiting at the NACE Ninth Annual Conference and Exhibition at Chicago, March 16-20, 1953 at Hotel Sherman.

Please Send in
NEWS
for October Issue
of CORROSION
to Reach Central Office
Before
SEPTEMBER 10

Corrosion Problems

E. A. TICE, Editor

Corrosion Engineering Section, The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Submit questions and answers for this column in duplicate to the editor. All questions become property of NACE. Questions and answers may or may not be published under this heading, and may at discretion, be answered by mail directly. Answers to questions are solicited. Authors of questions will remain anonymous to readers while authors of answers may remain anonymous if they request it.

QUESTION

No. 54—Has there been any experimental evidence to indicate that passivation treatments for stainless steels are effective when the steel is used in aqueous media at temperatures such as 200 to 250 degrees C?

ANSWER

Sven Brenner made some studies along this line in Sweden around 1935 (see *Jernkontorets Annaler*, p. 281 (1935) and *Metal Progress*, Vol. 31, 641-642 (1937)). He measured the potential necessary to penetrate and break down the passive or oxide film in 0.1 N sodium chloride solution. The principle of the method used is that the surface to be examined is exposed to an increasing anodic polarization in relation to the solution; it is then determined how far the polarization can be raised without inducing localized attack. Brenner calls the maximum potential the "perforation potential" and regards it as a measure of the resistance of the given material to corrosion by the electrolyte used in the experiments. He found that as the temperature of the electrolyte increased, the so-called "perforation potential" decreased and approached zero at 160 degrees F and above. It is inferred that as the temperature of the electrolyte increases, the tendency to local breakdown of the oxide film and subsequent localized corrosive attack increases. Whether or not the data obtained by Brenner holds true in electrolytes other than sodium chloride may be open to question.—Arba Thomas, Armco Steel Corp., Middletown, Ohio.

QUESTIONS

No. 98—In connection with the use of non-ferrous materials exposed to natural atmospheres polluted heavily with hydrogen sulfide, have any tests been conducted to determine what, if any, plating will eliminate serious corrosion without interfering with electrical current carrying characteristics? Short life of copper and bronze parts of open type, pole mounted switches, due to corrosion has been reported by two oil refineries and hydrogen sulfide has been suspected as the culprit. What are the possibilities of electroplating with cadmium, tin, nickel or chromium as a solution to this problem?

No. 99—Underground steel structures Nos. 1 and 2 cross each other. Structure No. 2 has such poor insulation that it is of no value. Structure No. 1 is bare and has magnesium anodes installed every 50 feet for cathodic protection. The earth gradient is thus

lowered a maximum at the No. 1 structure. The rate of earth gradient change is a maximum nearest the No. 1 structure and is practically zero 75 to 80 feet either side of the No. 1 structure. The resistivity of the earth is not necessarily uniform where the two structures cross and the No. 2 structure-to-earth potentials show that this structure is positive to earth in the vicinity of the crossing after the magnesium anodes are installed and connected to the No. 1 structure. The potential of the No. 2 structure at the crossing location was zero, or negative 0.55 volts to a copper sulfate half cell, before the magnesium anodes were connected to the No. 1 structure. Will a zero resistance band be required between the two struc-

tures to prevent an exposure to the No. 2 structure and can the true structure-to-earth potential of the No. 2 structure be determined at the surface of the ground?

No. 100—How can an underground valve flange be insulated so that the insulation will be more or less permanent?

No. 101—What is a good way to measure the current in an underground pipe line from which there are no soldered leads?

NACE will publish an annual directory of committee members including all organized committees of the association.

News Deadline for

CORROSION

10th of Month Preceding
Month of Publication

NACE Secretaries may obtain on request copies of "NEWS REPORT to CORROSION"

Notices of meetings to be run in advance should be sent in two months before the meeting date. These notices may include as much information as is available at the time including the date, time, place, name of speakers and topics to be discussed. Tentative programs are suitable for publication. Names and addresses of persons to receive registration and fees in advance should be given.

Reports on meetings prepared after the meeting may include all the events, with names and company affiliations of speakers, together with titles and a summary of the speakers' comments. Photographs taken during meetings are welcomed and will be run when they arrive in time for use. Where officers have been elected or changed the specific time at which they assume office should be given.

CORROSION is anxious to cooperate with associations and organizations other than NACE in carrying notices in advance of meetings and reports of meetings when these meetings include events interesting to NACE. The same deadlines as those applying to NACE communications apply to notices from other organizations.

The NACE always welcomes receipt of comments or discussions of its technical material. Persons who wish to discuss constructively technical material in CORROSION are invited to submit three copies to: Central Office, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas.

South Central Meeting Program Changes Made

Announcements of several officials and several changes and additions to the technical program for the South Central Region's October meeting have been made. John E. Loeffler, Technical Program chairman, gave the following changes in the program:

Oil and Gas Industry Symposium.—The fourth paper in the symposium will be "Corrosion Resistance of Straight Chrome Steels to Gas and Oil Environments as Affected by Heat Treatments for Specific Mechanical Properties," by E. K. Bloom, Research Metallurgist, Armco Steel Corp., Research Dept., Baltimore, Md.

Processing Plant Symposium. First paper in this symposium has been re-titled "Corrosion Control in the Small Refinery," and is by W. B. Trusty, Chief Chemist, Arkansas Fuel Oil Co., Shreveport, La. The title of Fred A. Prange's paper in this same symposium has been changed to "Designing for Corrosion Services."

Oil and Gas Transportation Symposium. In place of the paper by George L. Dehn which was transferred to the management session, the following paper has been added: Cathodic Protection of an Under River Pipe Line Crossing, by C. C. Loyd, Inspection Department, Esso Standard Oil Co., Baton Rouge, Louisiana.

Officials of the management session of the Oil and Gas Pipe Line Symposium have been named as follows: Earl W. Unruh, Sinclair Pipe Line Co., Independence, Kan., chairman; C. C. Keane, Chief Engineer, Great Lakes Pipe Line Co., Kansas City, Mo., co-chairman; and Gordon L. Doremus, Cathodic Protection Service, Houston, and George D. Hall, Thornhill-Craver Co., Houston, aides.

A discussion has been added to this session as follows: Review of Some of the Work of the Condensate Well Corrosion Committee of the Natural Gasoline Association of America and Its



OIL AND GAS TRANSPORTATION SYMPOSIUM authors of some of the papers to be given at the New Orleans South Central Region NACE meeting are: (Top row, left to right) J. D. Sudbury and D. A. Shock, Development and Research Dept., Continental Oil Co., Ponca City, Okla.; C. C. Loyd, Inspection Dept., Esso Standard Oil Co., Baton Rouge, La.; (Authors of two papers part of the Oil and Gas Pipe Line Management Session) Ivy M. Parker, Field Technologist, Plantation Pipe Line Co., Atlanta, Ga., and (bottom left) George L. Dehn, Southwestern Manager, Magnaflux Corp., Dallas.

Relation to Similar Work of Committees of NACE, by W. H. Stewart, Sun Pipe Line Co., Beaumont, Texas.

A technical paper has been added to this session also as follows: Inspection of Transportation Equipment to Prevent Corrosion and Failures in Use by George L. Dehn, Magnaflux Corp., Dallas, Texas. This paper has been transferred from the Oil and Gas Transportation Symposium.

Hot Dip Galvanizers

The 1952 Semi-Annual meeting of the American Hot Dip Galvanizers Association, Inc. will be held at White Sulphur Springs, West Virginia September 24-26.

Continuous Motion Pictures Planned For N. O. Meeting

Plans have been made for a program of continuous motion pictures at the South Central Region meeting of the National Association of Corrosion Engineers at New Orleans October 1-3. A cycle which will cause the pictures to be shown twice daily is contemplated.

Tentatively scheduled films include:

Highway for Oil—Color and sound, showing construction of pipe line by Humble Pipe Line Company about 40 years ago. 30 minutes.

Map of an Empire—Color and sound, showing pipe line construction in Louisiana swamp and in the Gulf South by United Gas Corp. 30 minutes.

Operation Take-Up—Color and sound, showing reworking of a large pipe line by Interstate Pipe Line Company. 14 minutes.

Plastic Pipe Construction—Color and sound, showing manufacture of Tenite and applications by Tennessee Eastman Corp. 27 minutes.

Salt Water Disposal by Injection—Color and sound, shows organization and function of a program for salt water disposal by East Texas Salt Water Disposal Co. 25 minutes.

Manhattan Spotlight—Black and white with sound, featuring J. M. Hamilton of North East Region explaining many phases of corrosion. 14 minutes.

Southern Pacific—100 Years in Texas—Sound and color, first showing of film by Texas and New Orleans Railway Co. Includes photographs of early locomotives and problems of building railroad on Gulf Coast plains. 20 minutes.

Corrosion and Corrosion Proof—Color and sound animated sequences of corrosion attack, from research by Allegheny Ludlum Steel Co. 26 minutes.

NACE will publish an annual directory of committee members including all organized committees of the association.

Gives you a quick, easy method of determining what metal alloys to use in connection with 143 different corrosive agents. Ideal for metallurgists, product designers, engineers, chemists, purchasing agents. Sized to fit your pocket. Developed by The H. M. Harper Co., America's leading specialist in non-ferrous and stainless fastenings.

FREE MAIL COUPON TODAY!

Chief Metallurgist,
The H. M. Harper Co.,
8221 Lehigh Avenue, Morton Grove, Ill.

Please rush my free copy of the Harper Computer of Corrosion Resistance.

Name.....

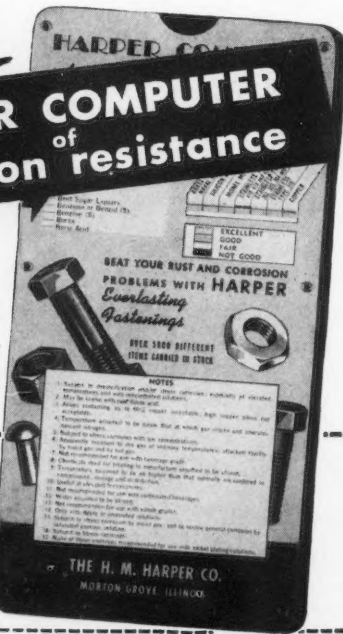
Company.....

Address.....

City..... State.....

SEND FOR YOURS TODAY!

HARPER of corrosion resistance





SOME OF THE AUTHORS OF PAPERS in the Oil and Gas Production Symposium to be given at the South Central Region Meeting at New Orleans October 1-3 are: (Top, left to right) T. P. May and R. B. Teel, Corrosion Engineering Section, The International Nickel Co., Inc., New York; Kenneth C. Eilerts, Principal Physical Chemist, U. S. Dept. of Interior, Bureau of Mines, Bartlesville, Okla.; F. K. Bloom, Research Metallurgist, Armco Steel Corp. Research Laboratories, Baltimore, Md.; (Left) Charles C. Nathan, Research Chemist, The Texas Company, Bellaire, Texas.



OFFICIALS OF OIL AND GAS PIPE LINE SYMPOSIUM Management Session: (Top, left to right) Earl W. Unruh, Chief Engineer, Sinclair Pipe Line Company, Independence, Kan., chairman; G. D. Hall, Mechanical Engineer, Thornhill-Craver Co., Houston, and (left) Gordon L. Doremus, Chief Engineer, Cathodic Protection Service, Houston,

aides. The photograph of Charles C. Keane, Chief Engineer, Great Lakes Pipe Line Co., Kansas City, co-chairman, was not available.

Motion Picture Shows Nickel Plating of Pipe

Fabrication of nickel-plated pipe is shown, among other things in a recently produced industrial sound motion picture called "The Alco Products Story." The 15-minute movie is available in either 16 or 35 mm editions from American Locomotive Co., Public Relations Dept., Schenectady 5, N. Y.

Address on Corrosion

Richard Pomeroy, consulting chemical and civil engineer, Pasadena, Cal., will address the California Municipal Utilities Association Thursday, October 2, at 10:15 a.m. on "Corrosion and Its Cost." This is one item on a program to be held September 30-October 3, inclusive at the U. S. Grant Hotel, San Diego, Calif.

Colonel Milwit Named

Col. Herbert Milwit, who was chief of the intelligence division of the Office of the Chief Engineer in the European Theater of Operations from June, 1942, to December, 1945, has been named head of the Engineer Research and Development Laboratories, United States Army, at Fort Belvoir, Va.

NICOLET *Medium Weight* ASBESTOS PIPE LINE FELT FOR COMPLETE PROTECTION WITH ECONOMY

Here's Why—

1. Lower Material Cost.
2. More coating and wrapping machine travel without changing rolls.
3. Save about one-half the freight.
4. More flexible asbestos felt which permits a tighter application for enamel penetration and keying-on action-free escape of gases.
5. Enamel losses and patching are less because of this longer travel without changing rolls.
6. Smoother exterior with less lap edge.

WE ALSO HAVE

No. 1—Nicolet Regular 15#
No. 2—Nicolet Perforated 15#
For Mill or Yard wrap, greater lengths may be had to 5000' long.



For the finest in Asbestos Pipe Line Felt . . . in all weights
SPECIFY NICOLET—"The Felt With a Proven Past and a Future"

The Felt With a Future

MANUFACTURED BY:
NICOLET INDUSTRIES, INC.

70 Pine Street

New York 5, N. Y.

DISTRIBUTED BY:
MIDDLE WEST COATING & SUPPLY
207-A Daniel Bldg.
P. O. Box 153
Tulsa, Okla.
Ph. 2-5215
or 2-5216

Evaporation Techniques Aid in Electrodeposition

Evaporation techniques for the adhesion of electroplatings and solders to oxide-coated metals and glass have shown great progress at the Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

Some metals are difficult to electroplate or solder due to poor adhesion to their natural hard tenacious oxide coatings. When these coatings are removed new oxides are immediately formed. Metals such as aluminum, chromium and titanium become coated with an oxide film even at room temperature in a vacuum at pressures less than 10^{-5} mm Hg. Hence, it is desirable to secure adhesion to these metals by a process

which includes their oxides. Excellent adhesion to these oxides can be obtained by high vacuum evaporation techniques. Evaporated films of most metals that form hard adherent oxide coatings can be caused to adhere tenaciously to their own and to other oxides, including glass. Evaporated films of some other metals, particularly gold, silver and copper show poor adhesion to oxides. However, a metal of the latter group can be made to adhere tenaciously to a metal of the former group by high vacuum evaporation techniques. The vapors of the two metals can be deposited simultaneously in such a manner as to eliminate the oxide coating which normally hinders adhesion. Thus, to coat titanium with copper, titanium is first evaporated on the oxide-coated titanium. At the first



AUTHORS OF PAPERS in Processing Plant Symposium at the South Central Region's meeting in New Orleans October 1-3 are: (Top, left to right) A. W. Trusty, Chief Chemist, Arkansas Fuel Oil Co., Shreveport, La.; K. B. Seymour, Technical Director, Atlas Mineral Products Co., Mertztown, Pa.; (Middle, left to right) Fred A. Prange, Engineer, Test Division, Engineering Dept., Phillips Petroleum Co., Bartlesville, Okla.; Charles F. Lewis, Metallurgical Engineer, Cook Heat Treating Co., Houston; (bottom), F. L. Wh'ney, Jr., Corrosion Specialist, Process Section, General Engineering Dept., Monsanto Chemical Co., St. Louis.



ask the farmer's daughter!

When it comes to pumping water, farmers' daughters around the country could tell us a thing or two. To them pumping water means a lot of hard work at odd hours.

We can't come to the aid of the farmer's daughter but we can, through Centriline, reduce pumping costs, increase carrying capacity and permanently eliminate corrosion and tuberculation from all pipelines 16" and larger.* That's why forward looking city engineers and officials are contacting us every day.

*Pipelines 4" to 14" are cement-lined by the Tate Process.

evidence of titanium deposition the evaporation of copper is begun. At the first copper deposit the titanium source is turned off and the copper evaporation continued until no titanium shows through the surface. The resulting surface can be soldered to directly or can be built up by electroplating. This method can be adopted to coating rolls or flat plates in a continuous coater.

Responsible for the investigation on adhesion of evaporated coatings is Noel W. Scott, Physicist in the Engineer Research and Development Laboratories, Radiation Branch, Fort Belvoir, Virginia. Referring to this new process Mr. Scott said that outgrowths of the studies demonstrated that "... evaporated coatings can be used to advantage in processes for applying heat resistant coatings to metals, transparent conducting coatings to glass, and the manufacture of mirrors by a replica technique.

CEMENT-MORTAR LININGS FOR PIPES IN PLACE

2,298,688 FEET  OF EXPERIENCE

CENTRILINE CORPORATION

A subsidiary of Raymond Concrete Pile Co.

140 CEDAR STREET, NEW YORK 6, N. Y.

Branch Offices in Principal Cities of United States and Latin America

ON THE WEST COAST, WRITE PIPE LININGS, INC., P. O. BOX 3428,
TERMINAL ANNEX, LOS ANGELES, CALIFORNIA

Porcelain Enamel Forum

The 14th Annual Shop Practice Forum of the porcelain enamel industry will be held September 10-12 at the University of Illinois, Urbana. Sessions will cover 14 papers on new developments, high temperature ceramics, and control practices.



A Leading Southwestern Refinery STOPS CORROSION with **NATIONAL** TRADE-MARK Graphite Ground Anodes



RESULTS

- Lowest installed cost
- 90% of corrosion leaks eliminated within 5 years of first installation
- Labor crews reduced . . . trained men kept on the job
- Power equipment requirements much lighter
- Installation simplified in congested areas
- Much lower amortization cost due to longer anode life

The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

OTHER NATIONAL CARBON PRODUCTS

HEAT EXCHANGERS • PUMPS • VALVES • PIPING • TOWERS • TOWER PACKING • BUBBLE CAPS • BRICK • STRUCTURAL CARBON • SULPHURIC ACID CUTTERS • HYDROCHLORIC ACID ABSORBERS

THIS major producer has several million square feet of uncoated tank bottoms and hundreds of miles of underground piping. Maintenance was heavy. Studies indicated cathodic protection — *but how?*

The high current necessary to give continuous, positive protection dictated the use of an impressed current system. First estimates favored scrap steel over graphite rods on a cost-per-unit basis.

But experience revealed a multitude of hidden costs and operating difficulties in the installation of steel scrap.

Scrap had to be welded. It required heavy trenching and transportation equipment . . . large labor crews. Bad weather held up men, machines and progress.

Re-evaluation clearly favored a "distributed" system of vertically-installed "National" Graphite Ground Anodes—which were specified for the whole of this large project.

WRITE FOR CATALOG SECTION S-6510

DOLLARS AND SENSE . . .
point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . delivering twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . has no metal can to leak or corrode.



BOOK REVIEWS

Corrosion Testing Procedures. By F. A. Champion. 369 pages, 5½ x 8½ inches, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York. Per copy, \$6.25.

Author divides the subject into five parts: 1) Choice and preparation of metal and corrosive. 2) Exposure of the metal to environment in laboratory, field or service tests. 3) Cleaning of specimens preparatory to examination. 4) Examination of the specimens or the corrosive for the effects of corrosion. Other measurements which indicate tendency to corrode and special tests. 5) Expression and interpretation of results.

The introduction summarizes the general considerations of corrosion testing emphasizing the need for considering both the metal and environment. In succeeding chapters by itemizing the factors entering into the tests and indicating to what extent variations in these factors may be expected to influence results, the author provides a lucid and easily read explanation of the procedures necessary.

Each chapter is followed by an extensive list of references arranged chronologically. There is an alphabetical author index and five-page alphabetical subject index. Correlation of the data presented in the very large number of references alone is a substantial work.

ASM Nominations for 1952-53 Are Made

Two nominating committees of the American Society for Metals have selected nominees for three top national officers and two trustees.

Nominated for president during the

1952-53 term was Ralph L. Wilson, Director of Metallurgy, Timken Steel and Tubes Division, Timken Roller Bearing Co., Canton, Ohio. He is now vice-president. J. B. Austin was nominated for vice-president. Mr. Austin is Director of Research Laboratories, U. S. Steel Co., Kearney, N. J. He is now one of the Society's national trustees.

Another committee, consisting of five immediate past-presidents of ASM nominated W. H. Eisenman to serve as National Secretary for his eighteenth consecutive term. Mr. Eisenman is a founder of the ASM. He has seen the organization grow from a membership of 200 drawn from the Chicago, Ill. area to the present 21,000 members.

Nominated to fill two vacancies on the board of trustees were: A. O. Schaefer, vice-president in charge of engineering and manufacturing, the Midvale Co., Nicetown, Penna. and H. B. Knowlton, chief engineer, materials engineering, International Harvester Co., Chicago, Ill.

Instrument Conference Scheduled Sept. 8-12

The Seventh Annual Instrument Conference and Exhibit will be held at Cleveland Public Auditorium September 8-12. Cooperating with the Instrument Society of America in the meeting will be the American Institute of Physics, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Cleveland Physics Society and the Scientific Apparatus Makers Association.

Corrosion Damage to Piers Checked With Radioactive Isotope

Corrosion damage to steel piers of the Saguenay Terminals, Ltd. dock at Port Alfred was checked through the use of a radioactive isotope and photographic film. Isotope Products Ltd., Box 127, Oakville, Ont. reported the testing was done by David Broom, a radiologist and Ed Wright, corrosion engineer, both of Aluminium Laboratories, Ltd. On seven piers selected at random, exposures were made every six feet down the underwater depth. The 50 exposures made confirmed the safety of the piers.

Dechema Monographs Book Is Offered

The new volume of Dechema Monographs soon to be published will include lectures on the theme "Materials and Corrosion," among others. The lectures were those delivered during the recent Twenty-Fifth International Congress of the Chemical Industry and the Achema X at Frankfurt am Main. The 500-page volume with 225 illustrations will sell to non-members of Dechema at Deutschmarks 37.50.

Copies may be ordered from Dechema, Deutsche Gesellschaft für Chemisches Apparatenwesen, Frankfurt am Main 13, Postfach.

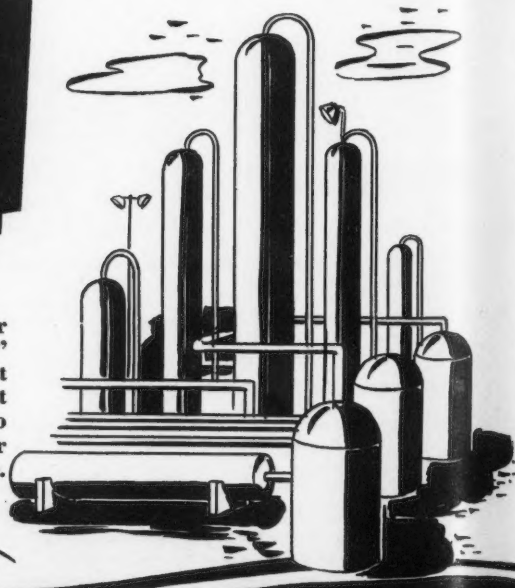
NACE will publish an annual directory of committee members including all organized committees of the association.

CORROSION ENGINEERS
Acclaim our new, Effective
"COPON"

If you have a corrosion problem at your plant, by all means investigate "COPON," the Epon resin coating, newest development for industries of the Gulf Coast area. Test it and you'll find it gives highly effective resistance to salt spray and chemical alkalis. Write for information or trial order.



COAST Paint & Lacquer Co. Inc.
P. O. BOX 1113 • HOUSTON, TEXAS





Marked for *Corrosion!*

Harco CATHODIC PROTECTION SYSTEMS CAN SAVE YOUR UNDERGROUND PIPING

The ravages of corrosion take an annual toll of \$600,000,000 for the maintenance and replacement of underground gas, oil and water pipe. You can protect your plant and cross-country piping from silent, vicious corrosion with a HARCO designed and engineered protection system.

HARCO corrosion control systems assure longer service life, minimum maintenance and replacement, elimination of "down-time" and protection from the hazards caused by corrosion damage.

To escape the costly fate of corroded pipe lines, call on HARCO . . . *first in the field of cathodic protection.*

WRITE TODAY for catalog
or call MONTROSE 2-2080. ▶



THE *Harco* CORPORATION *Cathodic Protection Division*
16991 BROADWAY • CLEVELAND, OHIO

CORROSION MEETINGS

1952

Sept.

4-6—AIChE (Regional Meeting) Chicago, Ill.

8-12—Instrument Society of America, Cleveland, Ohio.

10-13—Committee of Electrochemical Thermodynamics and Kinetics, Cambridge University, England.

Oct.

18-24—National Metal Congress and Exposition, Convention Halls, Philadelphia, Pa.

Positions Wanted

Graduate Metallurgical Engineer desires position as corrosion engineer. Nine years' experience in automotive and pipeline fields. Write CORROSION, Box 52-9.

26-30—The Electrochemical Society, Montreal, Que. Mount Royal Hotel.

Nov.

6-7—Tenth Annual Pittsburgh Diffraction Conference. Mellon Institute, Pittsburgh.

Dec.

7-10—AIChE, Annual Meeting. Cleveland, Ohio.

1953

Mar.

2-6—ASTM Spring Meeting and Committee Week, Detroit, Mich.

23-27—Eighth Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles.

April

12-16—The Electrochemical Society, New York. Statler Hotel.

20-22—Metal Powder Association, Cleveland, Ohio.

June

29-July 2—ASTM Annual Meeting, Atlantic City, N. J.

Sept.

13-17—The Electrochemical Society, Wrightsville Beach, N. C. Ocean Terrace Hotel.

21-25—Instrument Society of America, Chicago, Ill.



BOOKLETS

Control of Pipe Line Corrosion by O. C. Mudd.
Per Copy, postpaid \$ 1.25
(5 or more copies to one address, per copy, \$1)
Report of the Correlating Committee on Cathodic Protection. Bulletins I, II, III, IV. Per Copy, postpaid \$.50

TECHNICAL REPORTS

TP-3 First Interim Report on Ground Anode Tests. Publication 50-1.
Postpaid to NACE members, per copy \$ 3.00
To others, not NACE members, per copy 5.00
TP-2 First Interim Report on Galvanic Anode Tests. Publication 50-2.
Postpaid to NACE members, per copy \$ 3.00
To others, not NACE members, per copy 5.00
TP-1 Report on the Field Testing of 32 Alloys in the Flow Streams of Seven Condensate Wells. Publication 50-3.
Postpaid to NACE members, per copy \$ 8.00
To others, not NACE members, per copy 10.00

BOOKS

Joint Symposium on Cathodic Protection
Postpaid to members ECS and NACE, per copy \$ 6.00
To all others, per copy 8.00
Bibliographic Survey of Corrosion, 1945
Postpaid to NACE members, per copy \$ 4.00
To others, not NACE members, per copy 5.00
Bibliographic Survey of Corrosion, 1946-47
Postpaid to NACE members, per copy \$ 7.00
To others, not NACE members, per copy 9.00
1945 and 1946-47 Bibliographies Combined
Postpaid to NACE members \$ 9.00
To others, not NACE members 12.00
Proceedings First Annual Meeting NACE
Postpaid to NACE members, per copy \$ 3.00
To others, not NACE members, per copy 6.00

Address Orders and
Remittances to

NATIONAL ASSOCIATION
OF
CORROSION ENGINEERS

1061 M & M Bldg.

HOUSTON

TEXAS

CHROMATE CONVERSION FILMS

an important
new factor
in
protective
and
decorative
finishes



Chemical conversion films, formed by metal-finishing chromates, provide good paint adherence and corrosion protection on zinc, cadmium, aluminum, magnesium, iron and steel. These finishes are non-electrolytic, and should not be confused with those resulting from anodizing. The metal to be treated is simply immersed in the chromate-containing solution for a short period during which, according to accepted theories, the chromium combines with the basis metal to form a thin, complex oxide film. This film differs from chromate primers in that it becomes an integral part of the metal surface.

These chemical processes which employ sodium chromate, sodium bichromate and chromic acid are invaluable in extending the use of scarce metals in both military and civilian production. When compared to anodizing they have the advantage of being cheaper and quicker.

For further information, write to Mutual's Research and Development Department.

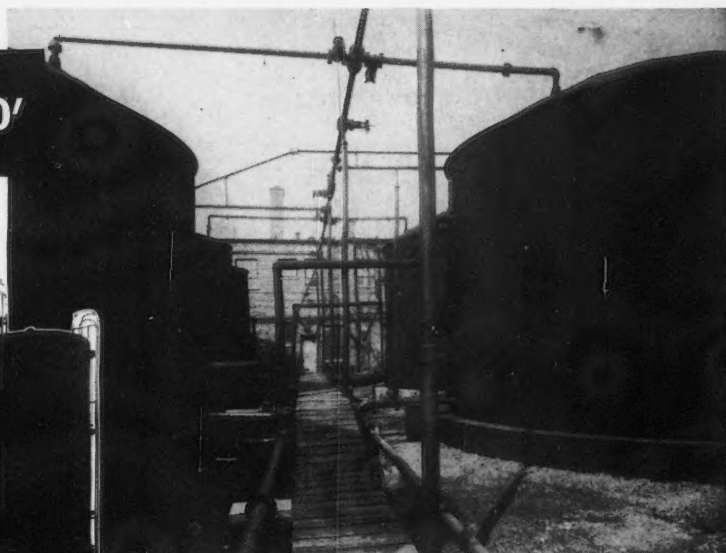
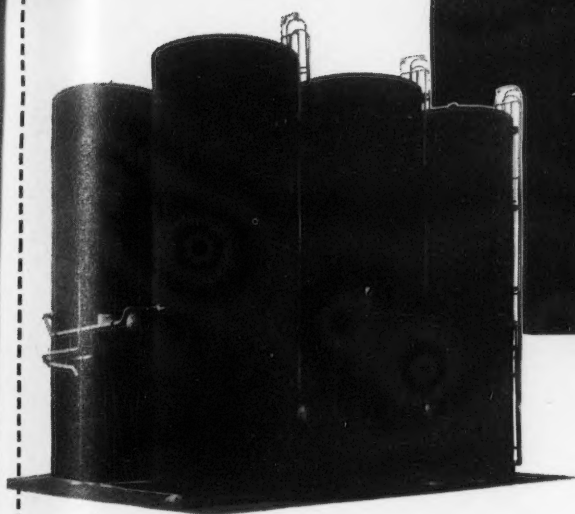
Sodium Bichromate • • Sodium Chromate
Potassium Bichromate Chromic Acid

Mutual Chemical Company of America

270 Madison Ave., New York 16, N. Y.

The coating that both insulates and prevents corrosion

INSUL-MASTIC TYPE 'D'



These photographs were taken in 1949 of fuel oil tanks which were sprayed with Insul-Mastic Type "D" *eleven years ago*. There has been no maintenance whatsoever needed during all these years. Today these tanks are still in excellent condition, and the Insul-Mastic Type "D" is providing corrosion protection and unimpaired insulating value.

Serves many years without maintenance

INSUL-MASTIC TYPE "D" is the dual purpose coating that not only insulates but also prevents corrosion. It is quickly applied to tanks, ducts, pipes and other metal vessels by spray gun and adheres at any angle without mechanical support.

INSUL-MASTIC TYPE "D" will stop heat flow through metal by 65%, and pays for itself in a short time by fuel saving—such as in the case of oil storage tanks, where heat is used to maintain a free flowing viscosity.

INSUL-MASTIC TYPE "D" also prevents condensation and has proven to be very effective on cold water intake lines in power

houses and other places where water absorbent insulations have given trouble.

INSUL-MASTIC TYPE "D" consists of granulated cork thoroughly mixed into a Gilsonite base binder, hence its corrosion preventive and adhesive properties. It is also resistant to most acids and alkalis.

INSUL-MASTIC TYPE "D" is effective between -40° to +300° F. Beyond these extremes, use the Insul-Mastic Vinyl System. Our nearest representative will gladly help you.

Write for further information or see our catalog in Sweet's Process Industries.

Insul-Mastic Corporation
OF AMERICA

1164 OLIVER BUILDING · PITTSBURGH 22, PA.
Representatives in Principal Cities



Major Improvement in Rectifiers Is Claimed for New Titanium Dioxide Unit

A NEW TYPE of rectifier recently developed by the National Bureau of Standards promises to be the first major improvement in metal-oxide rectifiers since their introduction in 1926. The new rectifier is composed of a layer of semiconducting titanium dioxide, a sheet of titanium metal and a counterelectrode of some other conducting metal. Although the development is still in an early stage, preliminary investigations have shown that the units withstand voltage in the reverse direction reasonably well and that their properties are satisfactory at elevated temperatures. Both the initial development and subsequent detailed exploratory investigations are the work of R. G. Breckenridge and W. R. Hosler of the NBS Solid State Physics Laboratory.

The earliest practical type of metallic rectifier was the copper-cuprous oxide rectifier, invented in 1926 by Grondahl, which consists of a copper sheet covered with a layer of cuprous oxide and a counterelectrode on top of the oxide layer. Many extensive investigations have been undertaken to develop similar rectifiers, but until now no other metal-oxide film combinations have been found that were feasible, although several non-oxide types have been produced—e.g., the selenium and magnesium-copper sulfide rectifier.

The new NBS rectifiers are prepared by forming a layer of titanium dioxide on a sheet of titanium metal and then

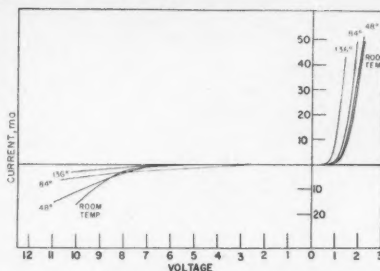


Figure 1—Characteristics of the new NBS titanium dioxide rectifier. A graph of current (in milliamperes) vs. voltage shows the performance of the metal oxide rectifier under various operating conditions. The unit has improved characteristics at temperatures around 150° C. It is also able to withstand a voltage in the reverse direction of about 20 volts per plate. The rectifier, for which these data were taken, had the oxide layer formed by being heated in steam at 600° C for 3 hours and 20 minutes. The contact area is 0.08 square centimeters and a silver plate is used as the counterelectrode.

applying a counterelectrode to the oxide surface. Two processes have been devised to form the oxide layer. The first process involves heating the titanium metal first in oxygen gas and then in hydrogen gas. The other—an improved version of the first—consists in heating the titanium metal in steam at elevated temperatures.

In the first process, 1/4-inch squares of commercial titanium metal sheet, 0.020 in. thick, are polished and heated in oxygen gas to form the coat of titanium dioxide. A thin, tightly adherent coat of oxide is obtained after a treatment at 800 degrees C for about two hours. The oxide layer formed in this manner becomes a very poor conductor of electricity; it is made into a semiconductor with a much greater conductivity by heating in hydrogen gas, which causes a loss of oxygen. A study of the reaction showed that heating in one atmosphere of hydrogen at 500 degrees C for 15 minutes would produce sufficient conductivity.

Counterelectrode Electroplated

After the hydrogen treatment, a counterelectrode is electroplated on the desired rectifying surface of the oxide by a-c plating techniques. A number of metals have been tried successfully as counterelectrodes, including silver, gold, tin, nickel, copper, zinc and cadmium, although silver has been used for the majority of the work. When the current is measured for various applied voltages, it is found to flow much more readily in one direction than the other; hence, the combination acts as a rectifier.

Rectifiers produced by the process are electrically satisfactory. However, the two-step process is difficult to control and in addition the oxygen and hydrogen gas tends to dissolve in the heated titanium metal and make it brittle. The second process of oxide formation, using water vapor, produces the semi-conducting oxide layer on the metallic titanium in one step. The most satisfactory films are formed by heating similar titanium

(Continued on Page 16)

Announcing THE NEW AND IMPROVED PEARSON ELECTRONIC COATING INSPECTOR

Used for locating voids in the coating of a completed pipe line — without uncovering the line — the new and improved Pearson Electronic Coating Inspector . . .

1. Has compact, light-weight receiver which weighs only 6 lbs.
2. Has greatly increased power output in signal generator which is arranged for self-contained batteries.
3. Has replaceable vibrator unit in signal generator for assuring continuous field operation.
4. Has carrying case which houses complete unit, and permits operation during bad weather.

First manufactured by "NEMCO" ten years ago, the new and improved Pearson Inspector is the outgrowth of considerable and varied field experience, plus much research and development work.

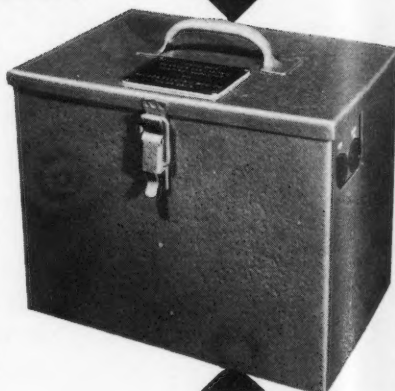
Write for new, illustrated Bulletin No. 941-A.

NELSON Electric MANUFACTURING CO.

217 N. Detroit St.

TULSA, OKLAHOMA

Telephone 2-5131



Outside view of metal carrying case



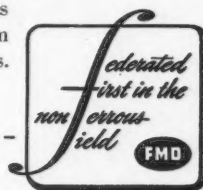
FEDERATED

ZINC ANODES

If your cathodic protection system is designed for zinc anodes, call Federated first.

Zinc anodes are available in standard lengths of three and five feet. They are cast from Special High Grade Electrolytic Zinc in shapes of 2 sq." and 4 sq." of cross-sectional area with full length chemically bonded steel core rod. Silver soldered connecting wires can be attached if desired.

If you are in doubt as to the proper applications for zinc anodes, Federated will send you a comprehensive report on "Zinc As A Galvanic Anode" prepared by Ebasco Services Inc. for the American Zinc Institute. If your protection system is designed for magnesium anodes ask for the Federated booklet, "Magnesium Anodes For Cathodic Protection." Use the coupon below for your free copies.



Federated Metals Division

American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.

ATTENTION: CORROSION ADVISORY SERVICE

Please send me { ☐ "Zinc As A Galvanic Anode"
FREE copy of { ☐ "Magnesium Anodes For Cathodic Protection"

NAME _____ TITLE _____

COMPANY ADDRESS _____

CITY _____ ZONE _____ STATE _____

Major Improvement—

(Continued From Page 14)

plates in steam at 600 degrees C for about three hours. The counterelectrodes are then electroplated in the same manner to form a finished unit. This process produces a rectifier with improved electrical properties but lacks the undesirable embrittlement accompanying the other method.

Properties Arouse Interest

While the titanium-dioxide rectifiers are still in a very early stage of development, some of their properties have aroused considerable interest. The units can withstand a reverse voltage of about 20 volts per plate. In addition, they have good properties at elevated temperatures; their performance is actually im-

proved with increasing temperature up to about 150 degrees C. Detailed studies have not been made of their operating life, but tests thus far are very encouraging.

Although the NBS titanium dioxide rectifiers bear a physical resemblance to the copper oxide type there are fundamental differences between them. For example, the direction of easy flow of current is opposite in the two types. In the titanium dioxide rectifier, the electrons flow from the titanium metal base plate to the counterelectrode. The mechanism of conduction in the metal oxides is also different. In cuprous oxide the charge carriers are "holes" or electron vacancies in the lattice, while in titanium dioxide semiconductors the charge carriers are free electrons. Finally, the "barrier layer," or asymmetrical potential that

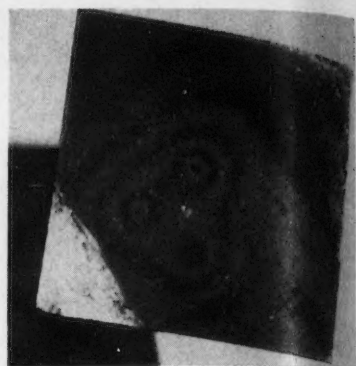


Figure 2—Laboratory test sample of the new titanium dioxide rectifier developed at the National Bureau of Standards. The rectifier plate has been specially processed to show the titanium metal (light corner), the dioxide coating (center portion), and the electroplated silver counterelectrode (darker corner). The plate is made of 1/2-inch squares of commercial titanium metal sheet, 0.020 in. thick. The rectifiers can withstand a reverse voltage of about 20 volts per plate, and have good properties at elevated temperatures.

must be surmounted by the charge carriers, apparently is located near the counterelectrode-oxide interface for the NBS type, while there is evidence that in the cuprous oxide device the barrier is located at the base metal-oxide surface.

Note: This report is summarized from a paper presented at the Washington Meeting of the National Research Council's Conference on Electrical Insulation, Oct. 29 to 31, 1961.

Reports of technical committees of the association are available for purchase by members and non-members.

AT LAST! AN ECONOMICAL, SHOCK RESISTANT INSULATING COUPLING

Until recently mechanical weakness and high costs have discouraged the large-scale use of insulating couplings on gas distribution systems. Now comes PESCO... safe, economical, rugged, easy to install, and assuring permanent electrical insulation.



Insulate your distribution system with PESCO INSULATING COUPLINGS*

PESCO couplings are designed and built to stand up under all types of extreme operational conditions. They are molded of nylon under high pressure. Nylon is a thermoplastic resin which is comparable to thermosetting resins in physical properties and far superior in chemical resistance and the ability to withstand bending, side thrust and shock. They stand pressures up to 1100 psi and are not affected by temperatures up to

300°F. Molding forms perfect threads and a "di-electric wall" inside the coupling to provide fool-proof electrical insulation and added sealing ability. A special locking device prevents the coupling from turning or slipping in its steel sleeve.

PESCO couplings may be installed by your regular workmen with their standard operating procedures. Available in all sizes from 3/4" to 2".

* Patent Pending

PLASTIC ENGINEERING AND SALES CORP.

P. O. BOX 1037

FORT WORTH, TEXAS

Lapel Pins



Approx.
Size

Approximately 7/16 inches high, gold, inlaid with bright red enamel background to "NACE" and deep blue enamel background to words "CORROSION CONTROL." Ruby center.

For Association Members Only

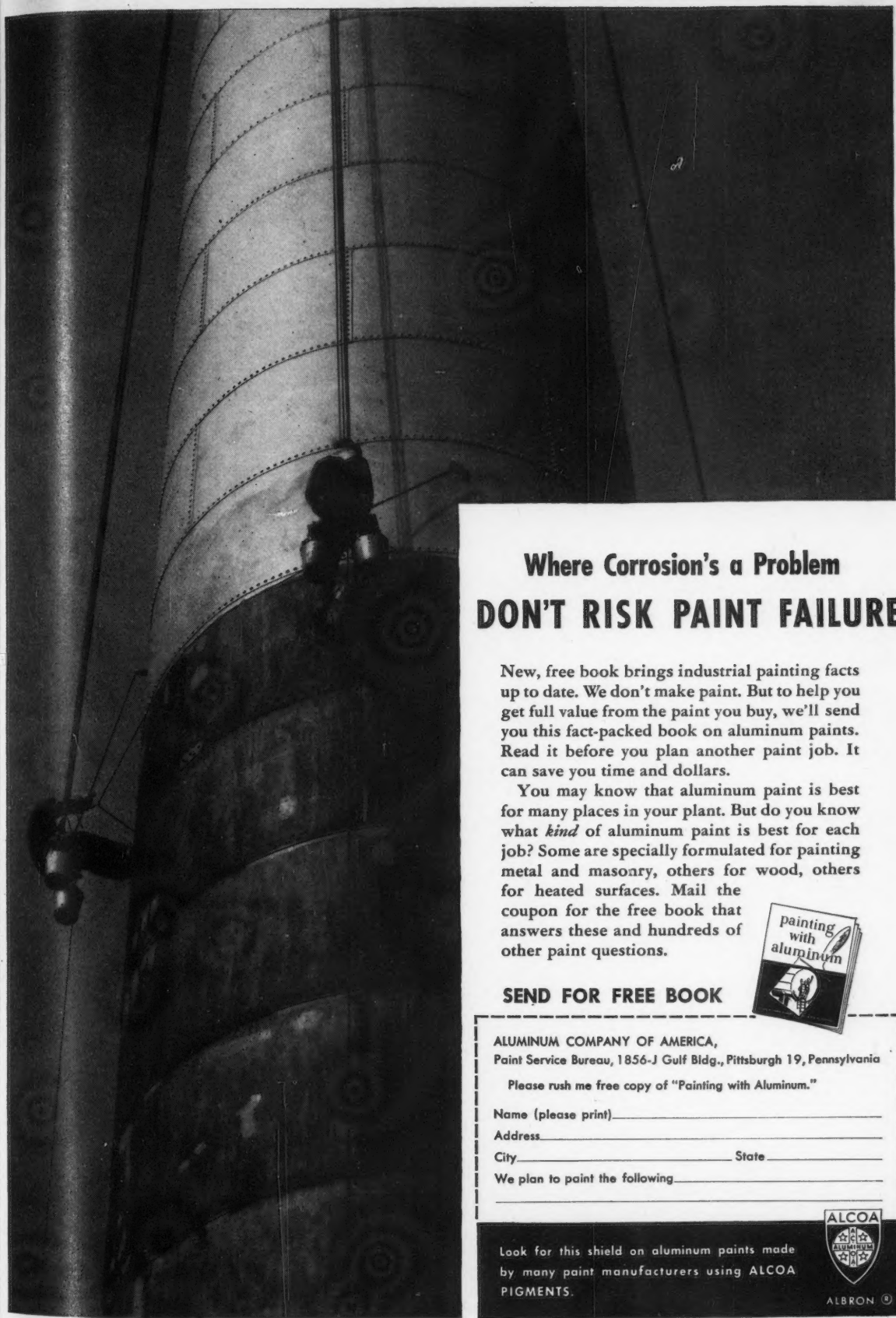
\$7

Address Orders to

A. B. Campbell, Executive Secretary

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

1061 M & M Bldg., Houston 2, Texas



Where Corrosion's a Problem DON'T RISK PAINT FAILURE

New, free book brings industrial painting facts up to date. We don't make paint. But to help you get full value from the paint you buy, we'll send you this fact-packed book on aluminum paints. Read it before you plan another paint job. It can save you time and dollars.

You may know that aluminum paint is best for many places in your plant. But do you know what *kind* of aluminum paint is best for each job? Some are specially formulated for painting metal and masonry, others for wood, others for heated surfaces. Mail the coupon for the free book that answers these and hundreds of other paint questions.



SEND FOR FREE BOOK

ALUMINUM COMPANY OF AMERICA,
Paint Service Bureau, 1856-J Gulf Bldg., Pittsburgh 19, Pennsylvania

Please rush me free copy of "Painting with Aluminum."

Name (please print) _____

Address _____

City _____ State _____

We plan to paint the following _____

Look for this shield on aluminum paints made by many paint manufacturers using ALCOA PIGMENTS.



ALBRON ®

NACE

New Members and Changes of Address

• This list is published principally for use by NACE Regional and Sectional officers in keeping their mailing lists up to date.

NEW MEMBERS

(Additions Through July 27, 1952)

ALABAMA

TALLANT, RALPH K., Alabama-Tennessee Natural Gas Co., P. O. Box 98, Florence, Ala.

CALIFORNIA

HANSEN, EDWARD M., 3214 Pennsylvania Ave., Santa Monica, Cal.

BENNETT, KEITH D., Solar Aircraft Co., 2200 Pacific Highway, San Diego 12, Cal.

BOYER, MYRON H., California Research & Development Co., 200 Bush, San Francisco, Cal.

SCHUMACHER, HENRY R., Richfield Oil Corp., Box 787, Wilmington, Cal.

SMITH, THEODORE J., Electric Steel Foundry Co., 249 First St., San Francisco 5, Cal.

RAINS, ROBERT K., Clayton Manufacturing Co., P. O. Box 550, El Monte, Cal.

COLORADO

KENYON, JOHN S., Public Service Co. of Colorado, 900 15th St., Denver, Col.

CONNECTICUT

WITHEFORD, JOHN M., American Cyanamid Co., 1937 W. Main, Stamford, Conn.

WORDEN, EUGENE T., The Stanley Works, 195 Lake St., New Britain, Conn.

DELAWARE

PELL, WILLIAM I., The Colorado Fuel & Iron Corp., Claymont, Delaware.

DISTRICT OF COLUMBIA

BENEDICT, RISQUE L., Naval Research Laboratory, Washington 25, D. C.

FLORIDA

SALINGER, RICHARD FISK, The South Atlantic Gas Co., Robinson, Orlando, Florida.

ILLINOIS

AMBLER, CHARLES W., JR., American Zinc, Lead & Smelting Co., P. O. Box 495, East Saint Louis, Ill.

PARIS, CHARLES G., Socony-Vacuum Oil Co., Inc., South 20th St., East St. Louis, Ill.

HOLZWORTH, MONTA L., Du Pont Liaison Office, Argonne National Laboratory, Ill.

LYON, DR. JOHN A. M., Dept. of Electrical Engineering, Northwestern University, Evanston, Ill.

SCHILLER, ALFRED F., Socony-Vacuum Oil Co., P. O. Box 110, E. St. Louis, Ill.

WIEBE, RICHARD, Northern Regional Res. Lab., BAIC, USDA, 825 N. University, Peoria, Ill.

INDIANA

RAUB, LYLE, 4528 Garfield St., Gary, Ind.

LOUISIANA

CORNELL, DREW, Bates & Cornell, 105 Stewart, Lafayette, La.

HENDRICK, JOHN O., JR., Dowell, Inc., Box 830, Lafayette, La.

MARYLAND

GLASSGOLD, I. LEON, Masonry Resurfacing & Construction Co., Inc., B & O Coal Pier, Baltimore 26, Md.

MICHIGAN

BROUWER, ARTHUR A., Dow Chemical Co., Materials Eng. Service, Midland, Mich.

CULLEN, JOHN L., Universal Oil Products Co., 74 Avalon Ave., Highland Park 3, Mich.

TIMM, LYLE A., Sharples Chemical, Inc., Wyandotte, Mich.

TINKLEBERG, NELSON, Upjohn Co., Per-tage Road, Kalamazoo, Mich.

MINNESOTA

GILLMAN, JONAS H., Toni Co., Lindeke Bldg., St. Paul, Minn.

SVERKERSON, WILLIAM C., Action Sales Corp., 9 N. E. Main St., Minneapolis, Minn.

MISSOURI

FRYKHOLM, OLIVER C., Corrosion Control Co., 1425 Broadway, Kansas City, Missouri.

LEBRECHT, G. FRANK, Anheuser-Busch, Inc., 721 Pestalozzi St., Louis, Mo.

NEW JERSEY

HECKER, CARL R., Basic Coatings Corp., 715 Elizabeth Ave., Elizabeth, N. J.

LINDEN, BERNARD J., U. S. Naval Res. & Dev. Facility, Bayonne, N. J.

VINCENT, CLARENCE, State Highway No. 38, Moorestown, N. J.

NEW YORK

AHLGREN, CARL R., National Aniline Div., Allied Chem. & Dye Corp., 1051 So. Park Ave., Buffalo 5, N. Y.

BARTER, HAROLD E., New York Telephone Co., 101 Willoughby, Brooklyn 1, N. Y.

BIGGER, TRAFFORD W., General Electric Co., 1 River Road, Schenectady, N. Y.

BLACKBURN, DOUGLAS B., Ford Bacon & Davis, Inc., 39 Broadway, New York 6, N. Y.

DEMPSEY, JOHN M., JR., States Marine Corp., 90 Broad St., New York 4, N. Y.

HAYES, WILLIAM B., Stauffer Chemical Co., Box 616, Niagara Falls, N. Y.

LONG, DAVID E., David E. Long Corp., 220 E. 42nd St., New York 17, N. Y.

RIEBLING, RICHARD G., Nukem Products Corp., 111 Colgate Ave., Buffalo, N. Y.

SAUNDERS, HARRY O., JR., American Tel. & Tel. Co., 195 Broadway, Room 2238, New York, N. Y.

VALENTINE, RALPH J., Lederle Labs. Div. of American Cyanamid Co., Middletown Rd., Pearl River, N. Y.

WOLFE, DR. WADE, JR., Mathelson Chemical Corp., Niagara Falls, N. Y.

OHIO

BARROWS, WILLIAM A., Barrows Porcelain Enamel Co., Langdon Rd. & Pa. R. R., Cincinnati 13, Ohio.

CARLSON, LAWRENCE A., Morton Salt Company, Rittman, Ohio.

FERRIE, PARMELY T., Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio.

FRIDDMAN, ARTHUR E., The Cleveland Hester Co., 2310 Superior Ave., Cleveland 14, Ohio.

HARRISON, JAMES R., c/o Pure Oil Co., P. O. Box 951, Newark, Ohio.

McWILLIAMS, ROBERT J., The Pfaunder Co., Taylor, Elyria, Ohio.

NOYES, HARRY F., JR., H. K. Ferguson Co., 1783 E. 11th St., Cleveland 14, Ohio.

RICHARDSON, E. WILLIAM, 1116 Broadview Blvd., Dayton 9, Ohio.

ROBB, LEWIS J., Pure Oil Company, Toledo, Ohio.

TRELS, EDWARD, Apex Smelting Co., 6700 Grant Ave., Cleveland 5, Ohio.

WILLIAMS, RAYMOND J., Cleveland Diesel Eng. Div. of General Motors, 2106 West 106th, Cleveland, Ohio.

(Continued on Page 20)

MONO-CAST PIPE

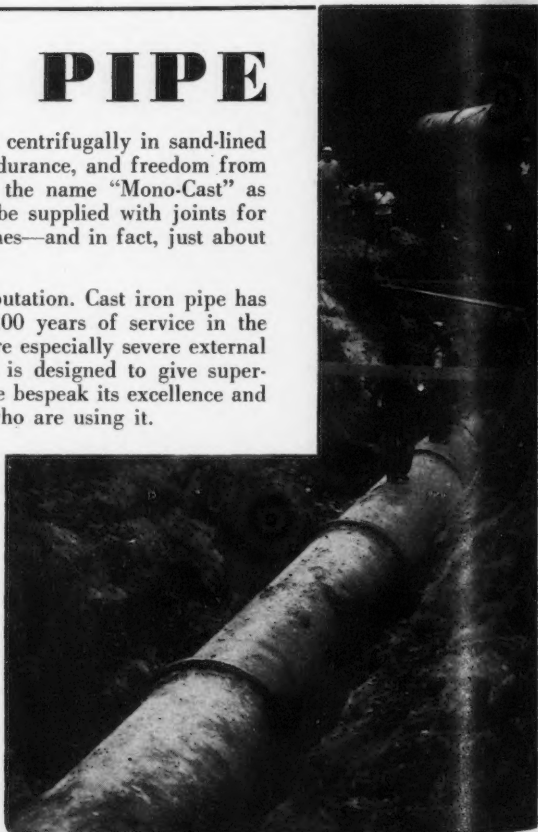
"Mono-Cast" is the trade name for ACIPCO pipe cast centrifugally in sand-lined molds. Uniform metal section, high physical strength, endurance, and freedom from inclusions are salient properties which have established the name "Mono-Cast" as synonymous with highest quality cast iron pipe. It can be supplied with joints for conveying water, gas, oil, gasoline, sewage, salt brine, ashes—and in fact, just about everything that a pipe line can conceivably convey.

Being cast iron Mono-Cast Pipe enjoys an enviable reputation. Cast iron pipe has had over 300 years of service abroad and more than 100 years of service in the United States. It is satisfactorily serving in locations where especially severe external and internal corrosion conditions exist. Mono-Cast Pipe is designed to give super-service; and its wide acceptance and splendid performance bespeak its excellence and the confidence and esteem in which it is held by those who are using it.

For many years our Company has pioneered in research, maintaining an experienced staff of chemists, metallurgists, engineers, and fully equipped modern laboratories. Refer your next piping problem to ACIPCO and utilize our extensive manufacturing facilities.

AMERICAN CAST IRON PIPE COMPANY

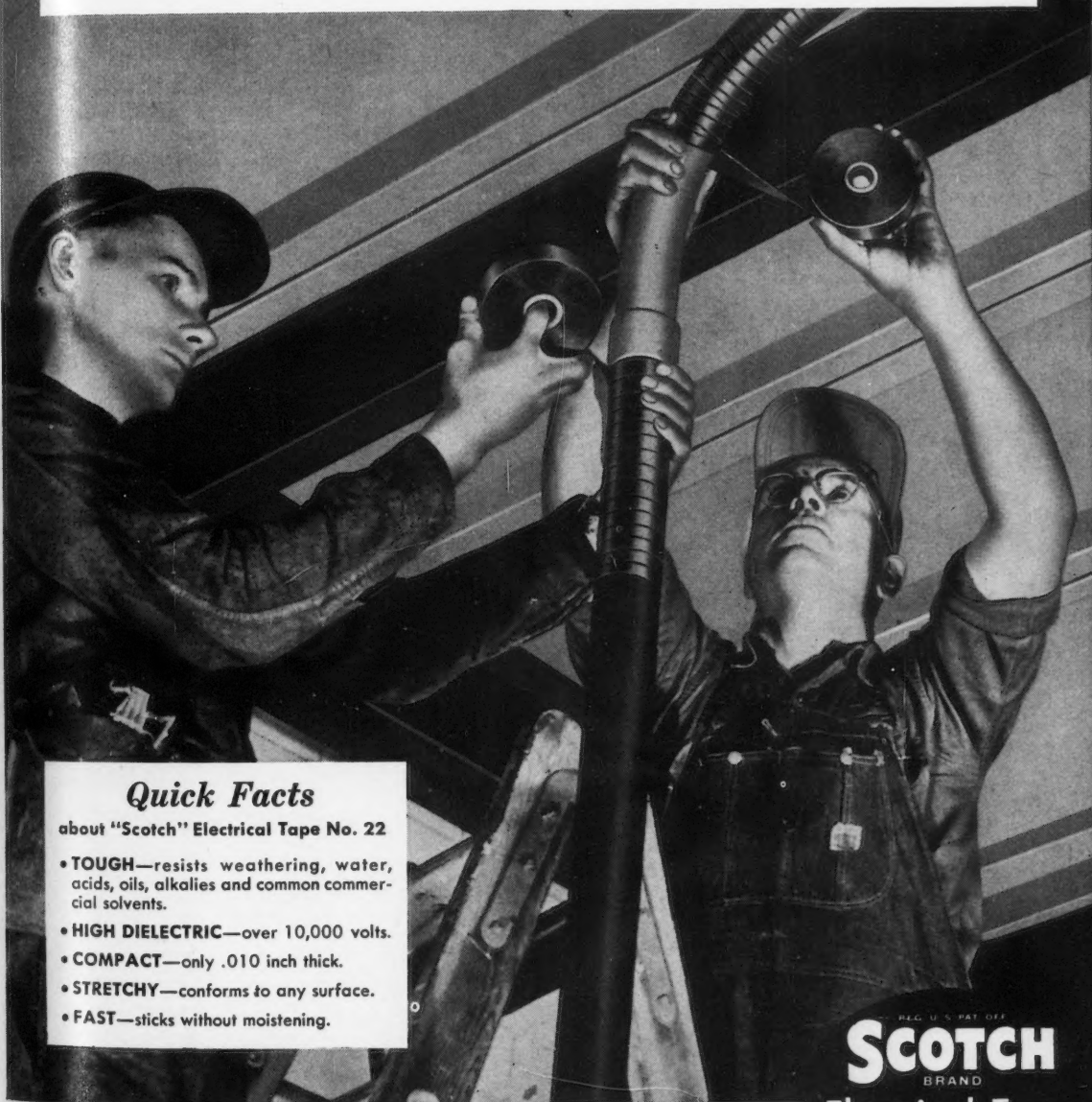
Birmingham 2, Alabama



Plastic tape "gets around" another tough problem!

What's the easiest way to put a dependable anti-corrosion coating on joints and fittings of pre-coated conduit? Wrap the bare spots with "Scotch" Electrical Tape No. 22! That's what the contractor for American Cyanamid Company did. Results are completely satisfactory.

This heavy-duty plastic tape can "get around" plenty of protecting and insulating problems for you, too. It's available in many widths and lengths for practically any requirement. Order a supply from your jobber today and see for yourself how long it lasts.



Quick Facts

about "Scotch" Electrical Tape No. 22

- **TOUGH**—resists weathering, water, acids, oils, alkalis and common commercial solvents.
- **HIGH DIELECTRIC**—over 10,000 volts.
- **COMPACT**—only .010 inch thick.
- **STRETCHY**—conforms to any surface.
- **FAST**—sticks without moistening.

The term "Scotch" and the plaid design are registered trademarks for the more than 200 pressure-sensitive adhesive tapes made in U.S.A. by Minnesota Mining & Mfg. Co., St. Paul 6, Minn.—also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ont., Can.



REG. U.S. PAT. OFF.
SCOTCH
BRAND
Electrical Tape
No. 22

New Members—

(Continued From Page 18)

OKLAHOMA

NICHOLS, HOWARD L., Shell Pipe Line Corp., Box 831, Cushing, Okla.
HOPSON, R. P., The Texas-Empire Pipe Line Co., Box 2426, Tulsa 2, Okla.

PENNSYLVANIA

DOELLING, ROBERT F., St. Joseph Lead Co., Monaca, Pa.
GORR, WALTER W., U. S. Steel Co., 525 William Penn Place Bldg., Pittsburgh 30, Pa.
MUMFORD, THOMAS R., Rust-Oleum Corp., Box 472, Pittsburgh 30, Pa.
McQUEEN, WILBUR C., Texas Eastern Transmission Corp., P. O. Box 32, Downingtown, Pa.

RHODE ISLAND

PLATT, RONALDS J. R., JR., Grinnell Company, Inc., 260 West Exchange, Providence, Rhode Island.

TEXAS

BENNETT, EDWARD E., Phillips Chemical Co., Box 277, Dumas, Texas.

DREW, A. E., Chief Engineer, Southland Paper Mills, Inc., P. O. Box 149, Lufkin, Texas.

DUDLEY, WILLIAM G., Dow Chemical Co., Bldg. A-906, Freeport, Texas.

DUESTERBERG, G. J., Plastic Applicators, Inc., P. O. Box 7631, Houston, Texas.

DULANEY, L. BOWEN, Rossion-Richards Co., 1090 M & M Bldg., Houston, Texas.

GREER, NORMAN E., Norman E. Green Co., P. O. Box 1311, Houston 1, Texas.

HUGHES, DAVID K., F. W. Gartner Co., 3805 Lamar Ave., Houston, Texas.

POWELL, HARRY F., Standard Brass & Mfg. Co., 2018 Franklin Ave., Houston, Texas.

WESTBO, L. H., Brance-Krachy Co., Inc., 4411 Navigation, Houston, Texas.

FOREIGN

BLY, HERBERT A., Creole Petroleum Corp., Judivana Office, Las Piedras, Estado Falcon, Venezuela, S. A.

HYSLOP, HEARD W., United Gas & Fuel Co., of Hamilton, Ltd., 82 King St. E., Hamilton, Ontario, Canada.

INCE, STRACHAN, Toronto Hardware Mfg. Co. Ltd., 450 Dufferin St., Toronto 3, Ontario, Canada.

JANSSENS, EMILE-VALERIE, Anciens Etablissements Emile Janssens 57A, Boulevard du Jardin Botanique, Brussels, Belgium.

JONES, DAVID C., Denton-Spencer Co. Ltd., 203 Barron Bldg., Calgary, Alberta, Canada.

MONTEMURO, MICHAEL M., Hydro-Electric Power Com. of Ont., 620 University Ave., Toronto 2, Ontario, Canada.

PORTER, HENRY P., Cathodic Protective Systems, Ltd., 632 View St., Victoria, B. C., Canada.

POWELL, HUGH M., Cathodic Corrosion Control, Ltd., 40 South St., London, W. 1, England.

PRESGOTT, COLIN, Hydro-Electric Power Com. of Ont., 620 University Ave., Toronto, Ontario, Canada.

RUSSELL, GEORGE B., Enfield Cables Ltd., 19 Mellinda St., Room 303, Toronto, Ontario, Canada.

SPARROW, LIONEL R., Iraq Petroleum Co., P. O. Box 51, Homs, Syria.

THATCHER, FRED G., c/o Creole Petroleum Corp., Las Piedras Falcon, Venezuela, S. A.

THOMAS, J. F. J., Industrial Waters Section, Department of Mines & Technical Surveys, Ottawa, Canada.

WEPLER, HARVEY S., Hydro-Electric Power Com. of Ontario, 620 University Ave., Toronto 2, Ontario, Canada.

CHANGES OF ADDRESS

(Old Address Follows New in Parenthesis)

ALABAMA

HECHT, LEON M., JR., 518 Sumerville Road, S. E., Decatur, Alabama (Woodlawn Drive, Nashville, Tenn.)

CALIFORNIA

DROBY, HENRY S., Pacific Gas & Electric Co., Electrolysis Dept., 4245 Hollis St., Emeryville, Cal. (102 Clay St., Oakland, Cal.)

MCCAMISH, HARLEY M., Cost Counties Gas & Electric Co., P. O. Box 4295, Avenal, Cal. Box A, Concord, Cal.)

NOSS, OSCAR F., JR., 2512 Knoxville Ave., Long Beach, Cal. (1222 East 1st St.)

TOTAH, NADIM P., Dorm. B12, Room 3, U. S. N. O. T. S., Inyokern, China Lake, Cal. (1121 La Branch St., Houston 3, Tex.)

VANGNES, K. T., The Vanode Company, 880 East Colorado St., Pasadena 1, Cal. (117 East Colorado Blvd.)

DELAWARE

DEGNAN, THOMAS F., 701 W. 22nd St., Wilmington 2, Del. (E. I. Du Pont De Nemours & Co., Chambers Works, Penns Grove, New Jersey.)

TORRANS, DAVID J., Hercules Experiment Station, Wilmington, Delaware (Hercules Powder Co., Parlin, N. J.)

ILLINOIS

BOONE, HAROLD C., 116 Iroquois Dr., Black Hawk Heights, Clarendon Hills, Ill. (Peoples Gas Light & Coke Co., 1017 Richmond St., Joliet, Ill.)

SHELVES, ARTHUR R., Himelblau, ByField & Co., 1217 West Washington Blvd., Chicago 7, Ill. (5650 McVicker.)

INDIANA

HOXIE, EARLE C., R. R. No. 1, Hillsdale, Ind. (1009 Jeter Ave., Bethlehem, Pa.)

IOWA

PETERSEN, CHARLES W., 1017 Conrey St., Knoxville, Iowa (426½ North 8th St., Beatrice, Neb.)

ROGERS, FREDRIC H., Box 135, Ames, Iowa (2017 W. Laurel St., Rt. 3, Independence, Kan.)

LOUISIANA

MALONE, MAURICE O., 3986 North Blvd., Baton Rouge 6, La. (903 Church St., Baltimore 25, Md.)

SCHUTT, RUSSELL W., Shell Oil Co., P. O. Box 193, New Orleans, La. (P. O. Box 595, Franklin, La.)

MICHIGAN

DOUGLAS, BURKE, Res. & Dev. Eng., Metallurgical Labs. Bldg. 241, Dow Chemical Co., Midland, Michigan (Electrochemical Engineering Dept., Bldg. A 966, Plant A, Freeport, Texas).

MISSISSIPPI

JAMES, H. E., Mississippi Valley Gas Co., P. O. Box 2447, West Jackson Station, Jackson 7, Miss. (Mississippi Power & Light Co.)

JONES, G. C., Mississippi Valley Gas Co., P. O. Box 2447, West Jackson Station, Jackson 7, Miss. (Mississippi Power & Light Co., P. O. Box 1640).

KEAN, E. E., JR., Mississippi Gas Co., Box 329, Amory, Miss. (Box 884, Columbus, Miss.)

NEW YORK

MITCHELL, RICHARD E., Shell Oil Co., R. C. A. Bldg., 50 West 50th St., New York, New York (P. O. Box 193, New Orleans, La.)

(Continued on Page 22)



Your eye tells you that here are two anodes . . . exactly alike. An ammeter will tell you that they both put out the same amount of protective current. Yet one of these anodes contains harmful impurities . . . nickel, iron, copper . . . impurities that will shorten the life of the anode and cost you unnecessary dollars for replacement.

The second anode is a STANDARD MAGNESIUM product . . . analyzed by our government approved spectrograph. A certified analysis report is furnished with each shipment of anodes. This report assures you that you are receiving a top quality product, which gives the most protection at lowest cost.

You're sure it's pure when you buy from . . .



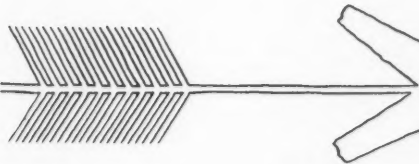
Standard Magnesium Corporation
TULSA, OKLAHOMA

calgon* threshold treatment

minimizes water system

maintenance costs

Calgon Threshold Treatment minimizes maintenance for water systems and stops unscheduled shutdowns because a molecular Calgon film shields pipes and heat transfer surfaces from corrosion. Calgon Threshold Treatment is specified for use in all types of industrial cooling water systems . . .



...because calgon

threshold treatment controls corrosion†

write for booklet
"Calgon Controls Corrosion"

Our engineers will be glad to discuss your particular problems with you. Write, phone or wire today. And write for your complimentary copy of our booklet, "Calgon Controls Corrosion."

†Calgon Threshold Treatment for controlling corrosion licensed under U.S. Patent 2,337,856.



calgon, inc.

*T.M. Reg. U.S. Pat. Off.

A SUBSIDIARY OF
HAGAN CORPORATION

HAGAN BUILDING
PITTSBURGH 30, PA.

Changes of Address—

(Continued from Page 20)

OHIO

NORD, G. L., Schaefer Mfg. Co., 4500 Alpine Ave., Cincinnati 36, Ohio (Box 95, Deer Parke Station).

WEST, LEWIS H., The Standard Oil Co., Products Pipe Line Dept., Box 631, Fostoria, Ohio (Sohio Pipe Line Co., P. O. Drawer D-15, St. Louis 1, Mo.) (885 E. Archwood, Akron, Ohio).

OKLAHOMA

NORRIS, R. J., Koppers Co., Inc. Tar Prod. Div., 310 Thompson Bldg., 20 E. 5th St., Tulsa 3, Okla. (P. O. Box 1074).

OREGON

HANEY, CHARLES E., Electric Steel Foundry, 2141 N. W. 25th Ave., Portland 10, Oregon (249 1st St., San Francisco, Cal.)

PENNSYLVANIA

FREEMAN, WILLIAM R., 50 Lanfair Rd., Cheltenham, Pa. (W. A. Briggs Bitumen Co., 3303 Richmond St., Philadelphia 34, Pa.)

LAMBERT, WILLIAM R., Texas Eastern Trans. Corp., P. O. Box 426, Somerset, Pa. (P. O. Box 431, Waynesburg, Pa.)

MOYAR, ROBERT E., P. O. Box 232, Rouseville, Pa. (Standard Vacuum Petr., Maatschappij. Prod. Dept. Sunsel Gerong, Palembang Sumatra, Indonesia).

PITTMAN, CHARLES U., Koppers Company, Inc., 500 Flannery Bldg., Pittsburgh 13, Pa. Westfield, N. J.)

RINGER, FRANCIS W., 7 Hampden Ave., Narberth, Pa. (The A. V. Smith Co., 121 Coulter Ave., Ardmore, Pa.)

RUTTER, CHARLES M. JR., Equitable Gas Co., 610 Wood St., Pittsburgh 21, Pa. (422 Blvd. of Allies).

SWENSSON, STUART J., American Hot Dip Galvanizers Assoc. Inc., 1506 First Natl. Bank Bldg., Pittsburgh 22, Pa. (2311).

TEXAS

ARMOUR, GILBERT A., 3917 Naples, Corpus Christi, Texas (1532 Nashua, Houston, Tex.)

JOHNSON, WAYNE A., Corrosion Rectifying Co., 1506 Zora, Houston 24, Texas.

LELEUX, C. J., Gulf Engineering Co., Inc., 1682 Ingebor, Houston 3, Texas (P. O. Box 1534, Corpus Christi, Texas).

MOCK, GUY C., Shell Pipe Line Lab., 3836 Bellaire Blvd., Houston, Texas (6636 England St.)

NEIL, FRANK M., Marshall, Neil & Pauley, Inc., Box 18062, Houston 3, Tex. (811 York St.)

PATTERSON, DON R., 3322 Burlingdell, Dallas 11, Tex. (The Atlantic Refining Co., P. O. Box 2819).

SMITH, O. R., Smith Contracting Corp., 1206 Continental Life Bldg., Fort Worth 2, Texas (205 N. W. 7th).

Nine Meetings Are Scheduled by Greater St. Louis Section

Meetings during each of the nine months beginning with September and continuing through May have been planned by Greater St. Louis Section. H. H. Uhlig of Massachusetts Institute of Technology is scheduled to address the section September 8 on "The Making of a Corrosion Engineer."

Other planned meetings are:

October 13—Harold A. Robinson, Dow Chemical Co., "Galvanic Corrosion and Cathodic Protection."

November 10—J. F. Wilkes, Dearborn Chemical Co., "Corrosion Problems in Ion Exchange Systems."

December 8—C. E. Ford, National Carbon Co., "Mechanical and Chemical Applications of Carbon and Graphite."

January 22, 1953—George C. Kiefer, Allegheny-Ludlum Steel Corp., "Welding of Titanium." Joint meeting with American Welding Society and Engineers Club of St. Louis.

February 9—R. McFarland, Jr., Hills-McCanna Co., "Valves and Pumps for Corrosive Service."

March 9—W. H. Mikesell, United Chromium, Inc., "Protective Coatings and Chemical Equipment."

April 13—T. E. Larson, Illinois State Water Survey Division, "Corrosion—A Water Quality Problem."

May 11—George Purdy, Tret-O-Lite Co., "Organic Inhibitors in Petroleum and Chemical Industries."

Harrison Is Elected President of Alloy Casting Institute

Officers elected by the Alloy Casting Institute at its twelfth annual convention at Hot Springs, Va., are Harvey T. Harrison, Duraloy Co., Scottsdale, Pa., president; G. A. Baker, The Duriron Co., Dayton, Ohio, vice-president. New directors elected were C. M. Carmichael, Stainless Steel & Alloys Division, Shawinigan Chemicals, Ltd., Montreal, Que. and M. N. Ornitz, National Alloy Steel Division, Blaw-Knox Co., Pittsburgh.

Chairman of the institute's technical research committee is N. A. Matthews of American Brake Shoe Co., Mahwah, N. J. and R. O'Connor, Cooper Alloy Foundry, Hillside, N. J. was named chairman of the shop practice committee.

PAINT OVER RUST

with

TYGORUST

That's right! You can paint right over rust with the new and different primer — TYGORUST — and, get excellent adhesion! Specifically developed for use under vinyl based coatings, TYGORUST virtually eliminates surface preparation — dries hard in minutes — covers up to 500-600 sq. ft./gallon — and, is rust inhibitive. What's more, its use is not limited to vinyls — it goes under any type of finish and provides excellent adhesion for all.

TYGORUST successfully primes iron and steel — clean or rusted — wet or dry. It can also be used on wood, concrete and previously painted surfaces (bituminous coatings excepted). It brushes easily — sprays beautifully. It can be over coated in as little as ten minutes.

Write for details, today — try TYGORUST, tomorrow! Give it the toughest tests — actually see how well it works!



PAINT OVER
TYGORUST WITH

TYGON PAINT

For maximum resistance to corrosive fumes and spillage, use the perfect running mate for TYGORUST — TYGON "Series TP" PAINT.

TYGON PAINT was created for use with TYGON PAINT. TYGON PAINT is created — more than ten years ago — to provide outstanding protection against acids, alkalis, oils, greases, and water. TYGON PAINT is quickly applied — dries fast — forms a tough, smooth, flexible film that's long lasting, easy to clean, and non-flammable when dry.

Use the best defense against chemical corrosion. Use TYGORUST plus TYGON "Series TP" PAINT. Write, right now, for full details and resistance data — ask for Bulletin 720.

PLASTICS
AND
SYNTHETICS
DIVISION



NEW PRODUCTS — Materials — Service — Literature

Carbo-Kote 6020, a thermosetting furan coating is described in a folder published by the Carboline Co., 7603 Forsyth Blvd., St. Louis 5, Mo. The company says Carbo-Kote 6020 is easy to apply, and is being used in many instances where baked-on linings, lead, rubber, glass or stainless steel were formerly required. It is said to be superior to stainless steel in acid and acid-solvent mixtures, practically all solvents and all alkalis as well as corrosive mixtures, salts, etc. The finished coating is hard and abrasion resisting. Durometer reading is 85-90. (Steel is 100), the pamphlet states.

Three Publications Have Been Issued by the International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., giving the properties of low carbon 8½ percent nickel steel, the mechanical properties of nickel deposits and the corrosion resistance of nickel plated metals. The first publication, a 12-page booklet titled "Some Properties of Low Carbon 8½ Per Cent Nickel Steel", describes a ferritic steel that is resistant to the embrittling effects of low temperatures (-320 degrees F.) and which can be welded and fabricated under conditions similar to engineering steel use. The booklet, "Mechanical Properties of Nickel Deposits," 12 pages, contains numerous photo-micrographs showing the wide range of properties that may be obtained in electro-deposited nickel by varying the solution and plating procedure. The booklet "High Corrosion Resistance Gives Nickel Plated Metals Wide Range of Uses," 4-pages, points out that nickel plating can often be the economical answer where service conditions do not justify use of solid corrosion resistant materials, because of nickel's good corrosion resistance to a wide variety of products.

Binks Manufacturing Co., makers of spray finishing equipment has opened a new branch sales office and warehouse at 1209 Levee St., Dallas, Tex. George H. Cook was named manager.

American Cladmetals Co., P. O. Box 544, Carnegie, Pa., is producing stainless steel clad copper to provide corrosion resistance of steel and cooling efficiency of copper in making cooling plates for soda fountains. The firm also reverses the foregoing procedure and produces a copper-coated steel sheet for use in making down spouts for homes. Strength of the steel, and the savings on copper are given as assets.

Abbeon Supply Co., 179 Jamaica Ave., Jamaica 32, N. Y. has published a small brochure on the uses of the firm's new automatic dehumidifier. The company claims its refrigeration type dehumidifier will, among other things, aid in preventing rust and corrosion.

"Plasite 7100," a new protective coating "with outstanding resistance to hot and cold acids, alkali, water and solvents" has been developed by the Wisconsin Protective Coating Co., 426 Elizabeth St., Green Bay, Wis. "Plasite 7100" cures at room temperature, and

can be applied to metal, wood, concrete and asbestos board by spray, brush or dip, the manufacturer states.

"Roylac Aluminum," a new industrial aluminum coating, that can be sprayed without spattering objects or surfaces four feet or more in the background, has recently been placed on the market by Royston Laboratories, Inc., Blawnox, Pa., after a two-year period of testing, the company says. It is claimed that because of its non-reactive vehicle, the coating is excellent on galvanizing, zinc, aluminum, magnesium, steel and other basic metals and provides a superior and tightly bonded corrosion-resistant film.

Pipe Line Service Corp., Franklin Park, Ill. has completed a new mill for coating and wrapping pipe sizes up to 30 inches in diameter and 60 feet in length. Grit cleaning machines, thermostatically-controlled melting kettles and other special equipment was designed and built in the machine shop by the company's engineers.

Wayne A. Johnson has formed the Corrosion Rectifying Co. specializing in cathodic protection, consulting, surveys, design and installation for combatting corrosion of pipe lines, storage tanks, offshore drilling platforms, elevated water towers and steel pilings. Offices are at 1506 Zora Street, Houston 24, Tex.

The Barrows Porcelain Enamel Co., Cincinnati, Ohio has developed a special ceramic coating for black steel tubing which in one instance, increased the useful life of the tubing by 12 to 20 times and saved two million pounds of metal. The average life of the black steel chlorination tubes used by Reynolds Metal for fluxing and degassing aluminum alloys was eight to ten minutes. The Barrows Company's ceramic is said to have extended the life of the tube to 148 minutes.

To Provide Protection against corrosion, Trans-continental Gas Pipe Line Corp.'s 24-inch line across the Narrows between Staten Island and Brooklyn, N. Y. was coated with a five-inch layer of "Somastic." For a negative buoyancy, a jacket of "Hevicote" three inches thick was applied. "Hevicote" is a dense concrete-like substance that weighs nearly 200 pounds per cubic foot. The bare pipe weighed 126 pounds per lineal foot. With both coatings, the pipe weighed 392 pounds per lineal foot. H. C. Price Co. processed the pipe for the job.

"Planning and Making Industrial Waste Surveys" is a practical manual for the conduct of a liquid-waste study in a manufacturing plant. It was prepared by the Metal-Finishing Industry Action Committee of the Ohio River Valley Water Sanitation Commission as a handbook describing methods of measuring flow volume, obtaining representative samples and calculating waste loads. Copies may be obtained by sending \$1.00 to: Ohio River Valley Water Sanitation Commission, 414 Walnut St., Cincinnati 2, Ohio.

Besly-Welles Corp., Beloit, Wis., is offering a tap manual which includes the latest information on taps for British-American Unified Threads. The bulletin also contains data on tap-drill sizes, selection of taps for various classes of work and kinds of material, feeds, speeds, how to sharpen taps, types of coolants and screw thread terms and definitions. Requests for this manual should be on company letterhead addressed to Besly-Welles Corporation, Beloit, Wis.

Process Associates, West Englewood, N. J., has been appointed selling agent for Laminex Corp. in the food, chemical and drug field, it was announced by Hugh Neville, president of Laminex Corp. The firm produces Fiberglas-reinforced plastic resin trucks, tanks and tubs. The equipment is used in the metal finishing industry for electroplate dipping and in the textile industry in finishing, yarn conditioning and dye handling.

Solar Aircraft Co., San Diego 12, Calif., has published a comprehensive brochure explaining how ceramic coatings can extend the life of metals used at high temperatures. Through ceramic coatings, low-cast, easy-to-get metals can be substituted for scarce, high-cost strategic metals, the brochure states. The brochure states their ceramic coatings will withstand reducing and oxidizing atmospheres, and "have reasonable resistance to chlorine, sulfur dioxide or trioxide, carbon dioxide, and vanadium gases; also will protect the metal, against attacks of liquid and gaseous lead bromide and molten sulfur." Solaramic coatings resist abrasion well also, according to the brochure. Methods of applying the coatings are demonstrated.

"Oildag," a colloidal graphite dispersion in oil, will lubricate metal surfaces under enormous strains in pounds per square inch, according to the manufacturers, Acheson Colloids Co., Port Huron, Mich. The firm states that one machine tool company has found "Oildag" eliminates binding and chattering in overloaded machines; the machine tool company includes a free bottle of "Oildag" with every machine shipped, it is said.

Koppers Co., Inc., Pittsburgh 19, Pa., is putting into operation a plant for producing tar-base enamel pipe line coatings and roofing pitches. The new plant is being erected at Fontana, Calif., adjacent to Kaiser Steel property, and will process tar received under contract from Kaiser's coke ovens. The plant will produce quantities of creosote oil and other distillates.

Atlas Mineral Products Co., Mertztown, Pa., has published a new information bulletin on the four basic types of corrosion-proof cements. The bulletin rates the corrosion resistance of each cement specifically for 176 common chemicals. The three principal methods of placing and joining the brick are illustrated.

E. I. du Pont de Nemours and Co. is
(Continued on Page 24)

New Products—

(Continued From Page 23)

producing a new rubber-like material in pilot-plant quantities. Called "Hypalon" S-2, the material is described as completely resistant to ozone and is a prospect for use in tire treads and white sidewall tires, protective coating for weather-stripping cars, new blends of rubber and insulation.

Union Carbide and Carbon Corp., New York, N. Y., has announced a 15 percent reduction in the price of ethyl silicate, condensed. The product is used in precision casting, acting as a powerful binding agent for the investment sand and helps achieve flawless mold surfaces.

Branson Instruments, Inc., 430 Fairfield

Ave., Stamford, Conn., has developed an aid in the use of the ultrasonic Audigage Thickness Tester. A magnetic fixture holds the searching unit against the plate or metal being tested. The non-destructive method can be used in testing the extent to which corrosion has eaten into and reduced in thickness metal fractionating columns, bottoms and sides of storage tanks.

Cooper Alloy Foundry Co., Hillside, N. J., has demonstrated an automatic, heavy-duty mold making machine capable of turning out a complete mold every two and one-half minutes. The process was developed from experiments carried on by Germany during World War II. The molten metal is poured into thin, plastic-bonded shells rather than into heavy sand molds. Parts can be cast

to closer tolerances than with the usual methods.

Thompson & Co., Oakmont, Pa., has developed an iron oxide zinc chromate primer for steel and iron which can be re-coated with lacquer or any other finish coat within three minutes after application without lifting or crazing, it is claimed. The product, SP-3523H, can be applied by spray, brush, flow coat or dip. A film thickness of .00075-inch on steel showed an ASTM salt spray resistance of 250 hours, 500-hour humidity resistance (100 percent relative humidity, 100 degrees F), and room temperature immersion in water 250 hours.

Armite Laboratories, 6609 Broad St., Los Angeles 1, Calif., has developed a new joint seal compound to insure easy removal of clean-out plugs and to serve as an anti-seize coating. The product is called "Compound 411." It is principally composed of metallic lead, and is said to be impervious to air, water, steam, oils, ammonia and hydrocarbons, is satisfactory for use in joints or on any threaded fittings, withstanding a temperature range from -100 degrees F through 2987 degrees F. Samples may be obtained by writing the company.

Tri-Clover Machine Co., Kenosha, Wis., has produced an improved magnetic trap for extracting tramp iron and other ferrous metals from various fluids. The trap is particularly useful in processing chemicals, pharmaceuticals and foods, the company says. The trap consists of several pie-shaped magnets over which the fluid moves. The trap is wider and flatter and brings the product closer to the magnet with decreased velocity and turbulence.

Wayne Chemical Products Co., Detroit 17, Mich., is producing "Kemisol 'A'," a chemical solvent which the company say will clean parts better, quicker and at a lower cost. "Kemisol 'A'" is neutral, odorless, non-toxic and non-inflammable. Among other uses, the product is being used for cleaning auto parts before chrome plating, or lacquering and for cleaning machined aluminum aircraft parts.

The American Hard Rubber Co., 93 Worth St., New York 13, N. Y., has developed a hard rubber pump impeller which the firm states will deliver more liquid within its pressure range than any other pump in its size and price class. The pump is designed to handle acids, alkalis and other corrosives. The pump delivers 15 gpm at 22 ft. head, or 5 gpm at 72 ft. head. The pump is self priming. The pump casing is of corrosion-resistant hard rubber. Trade name of the pump is "The Ace Jabsco."

"Super Hot," an aluminum paint product of the Sheffield Bronze Paint Corp., Cleveland, Ohio, will withstand temperatures of at least 1600 degrees F and makers say that the more heat applied to the surface, the tighter the bond because the paint alloys itself to the metal. Cleaning the surface before applying the paint is recommended, but "Super Hot" will bond even through moderately rusty and greasy surfaces.

"Galvanite," made by the Galvanite Corp., 40 West 29th St., New York, N. Y., is a cold galvanizing compound

(Continued on Page 25)



CORROSION—the great saboteur—works night and day making old storage tanks useless and necessitating costly repairs to new. In some sour crude areas, new tanks have been rendered useless in as little as 18 months.

Now, with steel again in short supply, you will have to get the maximum years of life from each tank so there may be more steel for defense.

NATASCO products will prevent corrosion from getting a start on your new tanks and prevent further corrosion on old ones.

NATASCO corrosion prevention products have been proved by years of successful use. NATASCO also provides experienced crews for the preparation and application of these products.

CONTRACT SERVICES:

- Tank Welding Repairs and Maintenance
- Installation of Tank Appurtenances
- Tank Painting
- Application of Protective Coatings
- Tank Cleaning—BS&W Emulsion Chemical Treating

Learn how you can get the most in years of additional service from your tankage. Wire, telephone or write for complete information.



Lease Tank Service—West Texas Area:
Williams Construction Co.
Odessa, Texas

California Representative:
Coast Contractors, Inc.
2627 Atlantic Ave.
Long Beach 6, Calif.

New England Representative:
The McKin Company
P. O. Box 711
Portland, Maine

New Products—

(Continued From Page 24)

which, it is claimed, is in many ways superior to other surface protection techniques including electroplating, hot dipping, cementation, spraying and painting, H. L. Grebinar, a member of the company says. The coating actually combines with the base metal, setting up electrical continuity, and leaves a coating of 96 parts by weight of chemically pure zinc. It induces rusted areas to create their own non-flaking coating.

"Karbate" brand impervious graphite standard towers are described in a new catalog section published by National Carbon Company, 30 East 42nd St., New York 17, N. Y., a division of Union Carbide and Carbon Corp. The tower sections are highly resistant to corrosion, thermal shock or metallic contaminations. The catalog, designated "Catalog Section S-7350," contains complete specifications for all standard tower sizes with typical assembly and dimension drawings. It may be obtained by writing the company.

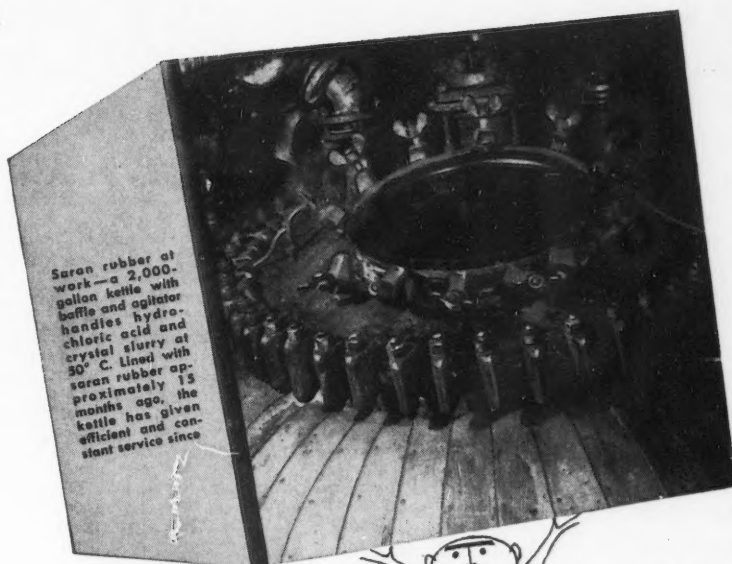
The Turco Metals Booklet describes the company's products and processing operations and which includes chemical processing operations in the metal-working industry. Turco cleaners, passivators, phosphatizing agents and dye penetrant systems of metal inspection are dealt with. Tables for conversion from English to metric systems, decimal equivalents, and methods of figuring areas are given. The booklet will be sent to any one who writes for it on his company letterhead. Address is Turco Products, Inc., 832 East 62nd St., Los Angeles 1, Cal.

Roto-Finish Co., P. O. Box 988, Kalamazoo, Mich., has expanded and improved its abrasive chip line. The Roto-Finish process is used for many operations, including grinding, deburring, de-scaling, polishing, brightening and coloring all types and sizes of ferrous and non-ferrous parts mechanically on a mass production basis.

Hays-Penn constant flow meters, through the use of stainless steel tubes, eliminates the distortions of hysteresis and friction-lag. The Hays-Penn type transmitter comprises a mercury U-tube, and a non-metallic float. Two reactance coils surround the high-pressure log, and a magnetic core supported by the float moves within the reactance coils. Through the use of a galvanometer, changes in current cause the recording needle to move. The meter is made by the Penn Industrial Instrument Corp., Philadelphia, Pa.

The Babcock & Wilcox Co., has announced significant results in relieving the problem of troublesome deposits on boiler tubes from the firing of residual fuel oil. By adding aluminum stearate or dolomite stearate to the fuel, a powdery deposit, easily removable is formed on the tubes. This contrasts with the hard, glassy, fused material that forms when additives are not used. Savings in down time for cleaning and other work are great, the firm says. More information may be had by writing George Aubrey Hastings, 1 Madison Ave., New York 10, N. Y.

(Continued on Page 26)



BOOST EQUIPMENT

LIFE!

use

SARAN

RUBBER TANK LINING!

The productive life of costly equipment often can be lengthened through the installation of saran rubber tank lining. Saran rubber's high degree of chemical and abrasive resistance makes it an effective lining wherever the corrosive inroads of grease, many solvents, acids and other chemicals should be checked.

Saran rubber tank lining helps bring lower operating costs to industries handling, storing or transporting corrosives. The lining can be applied easily and economically by experienced applicators located strategically throughout the country. Get in touch with an applicator today by contacting your nearest Saran Lined Pipe Company office.

Write to the Distributor:

SARAN LINED PIPE COMPANY

2415 BURDETTE AVENUE • FERNDALE, MICHIGAN

Offices in: New York • Boston • Pittsburgh • Tulsa • Philadelphia
Chicago • Portland • Indianapolis • San Francisco • Houston • Denver
Los Angeles • Seattle • Cleveland • Charleston, S.C. • Toronto • Montreal



for tank cars
storage tanks • tank trailers
processing tanks
production tanks

RELATED PRODUCTS

Saran rubber molded parts—stoppers, diaphragms, various-sized moldings for valves, instruments, etc.

Saran lined steel pipe—corrosion-resistant pipe that gives long-term operation with minimum maintenance costs.

Saran Lined Pipe Company

2415 Burdette Avenue, Ferndale, Michigan

Please send me your catalog on Saran Rubber Tank Lining and Saran Rubber Molding Stocks.

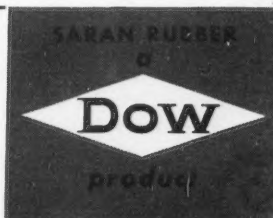
Name _____ Title _____

Company _____

Address _____

City _____ State _____

SP509B



New Products—

(Continued From Page 25)

Prufcoat Laboratories, Inc. announce a new metal primer, "Primer P-50", which can be applied with a paint brush after only routine wire-brushing, requires only overnight drying, and yet inhibits surface corrosion and ties active-solvent finish materials securely to the metal. Application costs are cut in half. Some of the advantages claimed are: Primer easy to apply and dries fast, only routine surface preparation necessary, control of underfilm corrosion obtained, assurance of positive adhesion and suitable for all types of finish materials. Inquiries should be addressed to G. Russell Hersam, General Sales Manager, Prufcoat Laboratories, Inc., 50 East 42nd St., New York 17, N. Y.

Pittsburgh Rolling Mills, Inc. is now producing non-standard, bright annealed stainless wire shapes. The firm markets rolled edge stainless flat wire, keystone shapes, half-rounds and various other shapes. They will also supply special bright annealed wire shapes to customer's specifications in a range of sizes. The wire is suitable for fabricated items such as cotter pins, wind shield wiper stock, carburetor and aircraft parts, oil well screens and products that require stainless wire with a bright annealed finish in special shapes.

Liquid Stainless Steel, made by the Slip-On Co., 401 Broadway, New York 13, N. Y., is said to be a coating composed of tiny flakes of stainless steel in

a plastic type vehicle. The firm also makes "Vinoplast," a top coat which gives a high gloss to surfaces, and a wash primer to be used where metals are to withstand severely corrosive environments.

"Vacuum Metallizing Today," a new comprehensive brochure, has just been published by F. J. Stokes Machine Co., Philadelphia, Pa. It describes in detail the low-cost coating process and how it can be applied to the surfaces of plastics, metals, glass, paper, textiles, leathers and many other products.

Chemiquip Co., 6 East 97th Street, New York 29, N. Y., has marketed a trap to recover mercury blown from manometers. Called the "Mercureceiver," the trap is also designed to dampen surges and pulsations, to filter actuating media and to remove harmful solids from the actuating media.

The Star Stainless Screw Co., 190 Union Avenue, Paterson 2, N. J., has published an illustrated catalog showing the various kinds of screws, bolts, nuts and other items made by the company.

International Nickel Co., Inc., 67 Wall St., New York, N. Y., has published a 36-page booklet which gives brief descriptions of the characteristics and uses of cast irons which vary in their alloying content (nickel, chromium, copper, silicon and magnesium). More than 150 technical terms used in the foundry trade are explained.

Penn Metal Co., Inc., has opened new

offices at 1205 Connecticut Ave., N. W., Washington, D. C., under the management of Cecil R. Cooley to cover the District of Columbia, Maryland, most of Virginia and part of West Virginia.

Dekoron Impervapak Metl-Cor, a new type corrosion resistant tubing harness has been developed by Samuel Moore & Co., Dekoron Tubing Division, Mantua, Ohio. It is composed of a bundle of copper or aluminum tubes over which is extruded a 1/16-inch thick sheath of high molecular weight black polyethylene.

Ampcoflex, a rigid plastic material available as extruded pipe with molded fittings, formed containers and fabricated tanks as well as square and round duct sections in standard sizes has been developed by Atlas Mineral Products Co., Mertztown, Pa.

Ace Glass, Inc., Vineland, N. J., has developed a new type of gas washing apparatus for laboratory use. Numerous advantages over the conventional bottle and stopper arrangement are claimed.

Vapor Corrosion Inhibitors for steel and aluminum are described in Technical Bulletin VT-1, available on request from Industrial Packaging Division, Berlin & Jones Co., Inc., 601 West 26th St., New York 1, N. Y.

Painting With Aluminum, an illustrated 32-page brochure available from Aluminum Company of America, Pittsburgh 19, Pa. describes the various

(Continued on Page 27)



The Gal would no doubt be welcome on a desert isle, back row of a movie, Saturday night square dance or any other civil (or un-civil) occasion. All Right, All Right, the Gal's name is Maude and her phone number is Webster 1941. Now, will you read the rest of this?

You'll admit she's pretty, but, have you seen one of our insulating bushings designed especially for gas meter service? How about letting us send you testing samples, the bushings that is, they'll speak for themselves. (Sure wish I had that Monkey's job!)

ALL TYPES OF INSULATION
CALL • • WIRE • • WRITE

SERVICE ENGINEERS, INC.

Manufacturers of Industrial Plastic Products

3030 W. Pafford

P. O. Box 11068

Fort Worth 9, Texas

New Products—

(Continued from Page 26)

kinds of aluminum paint available, recommends application procedures, and includes an extensive question and answer section and a coverage table.

Porcelain Enamel on aluminum is recommended by Halrick, Inc., 31 Crosby St., Danbury, Conn. as a coating highly resistant to strong detergents, acids, alkalis and sulfides. The coatings also have high resistance to thermal shock, impact, and can be welded on the reverse side without discoloration or damage.

Polyethylene and ethylene glycol will be produced at a new Los Angeles County plant of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corp.

Rodine, a standard pickling acid inhibitor, is listed by types in a chart available from American Chemical Paint Co., Ambler, Pa.

Shell Molded stainless steel valves, fittings and castings are being made by Cooper Alloy Foundry Co., Hillside, N. J. Copies of a reprint of an article describing the process are available on request.

Nu-Pon A, a resin base finish for spray application on exterior metal surfaces has been developed by the Glidden Company, Cleveland, Ohio. The material, which is derived from petroleum, is sprayed from a gun in which the finish and a catalyst are ejected simultaneously.

Parco Black, a jet black finish for iron and steel, said to have ten times the corrosion resistance of conventional blacks, has been developed by Parker Rust Proof Company, Detroit 11, Mich. Parts to be treated are immersed for 15 to 30 minutes in the product dissolved in water at low temperatures, then rinsed and dried. After oiling or waxing a deep black, durable finish is produced. A technical bulletin is available.

Ultrasonic thickness measurements on smooth surfaced homogeneous metals, glass, Lucite and other materials can be made with accuracies consistently within 1/4 of 1 percent of actual thickness, according to Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn., with an instrument called the Audigage Ultrasonic Micrometer. Quick coil adjustment and replacement for various thicknesses is possible.

Metacon 516, a rust remover of the phosphoric acid type, gives a corrosion-resistant coating to metals which in tests has protected the metal for as long as eight weeks. The material is made by Croda, Ltd., Croda House, Snaith, Goole, Yorkshire, England.

Neoprene is used for a flowerpot shaped shield designed to be placed over the stems of valves, covering the packing gland nuts, to protect workers from corrosives if the packing fails. The flexible shield may be turned back for inspection of the valves. Industrial

(Continued on Page 28)

AMERICAN CHEMICAL PAINT COMPANY

AMBLER  PENNA.

Technical Service Data Sheet

Subject: RUST PROOFING WITH PERMADINE®

INTRODUCTION:

Ferrous metal parts that have been Permadiized in a zinc phosphate chemical solution and then "sealed" with a rust-preventive oil such as "Granoleum" are effectively protected from rust-damage. In addition, if the surface is accidentally chipped or scratched, rusting is confined to the exposed area.

Rust proof coatings find many practical applications. During World Wars I and II most small arms were rust proofed by phosphate coating and impregnated with chromic acid and a rust preventive oil, or cutback petrolatum. This not only provided excellent corrosion resistance but also yielded a dull black non-reflecting surface. Rust proof finishes are now used widely on hardware, firearms, cartridge clips, metallic belt links, miscellaneous forgings and castings, tools, unpainted replacement machine parts, and many other similar items such as bolts, nuts, and washers.

THE PERMADIZING PROCESS:

For the most effective rust proofing of large or small work in large or small production, "Permadiene" is used in tanks in an immersion process, with the bath heated to 190°-210°F., coating time 20 to 30 minutes. The coated parts are then rinsed in clean water, and then in a controlled dilute acidulated solution. After drying, a suitable corrosion-resistant oil such as "Granoleum" is applied.

Operations can be carried out with the work in crates, or hung from hooks, utilizing an overhead rail and hoists. For large volume production, automatic equipment can be used to mechanize the line. Small parts can be treated in tumbling barrels.

"PERMADINE"

MEETS

SERVICE

SPECIFICATIONS:

The protective "Permadiene" finish meets U.S.A. 57-0-2C; Type II, Class B, and equivalent requirements of:

MIL-C-16232,

Type II

U.S.A. 51-70-1,

Finish 22.02, Class B

AN-F-20

Navy Aeronautical M-364

JAN-L-548

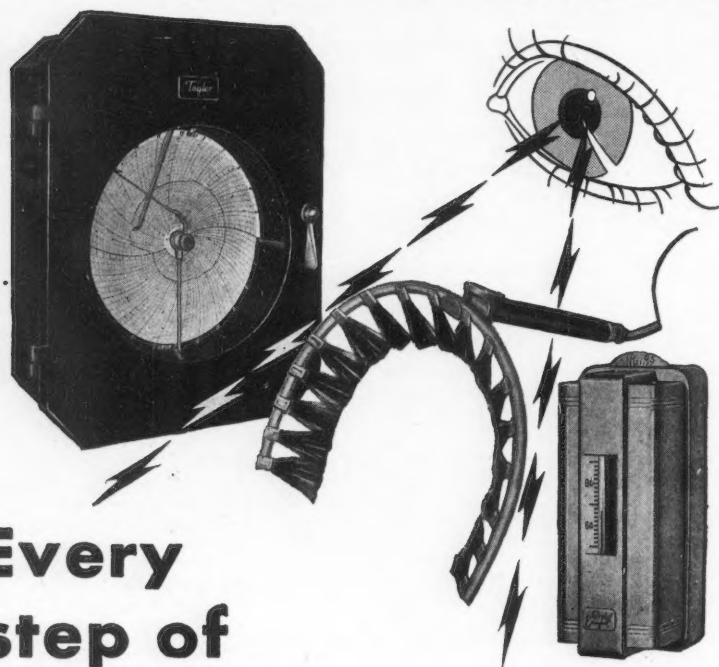
"PERMADINE" DATA CHART

Type of coating	Zinc phosphate
Object of coating	Rust and corrosion prevention
Typical products treated	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components
Scale of production	Large or small volume; large or small work
Method of application	Dip Barrel tumbling, racked or basketed work
Equipment notes	Immersion tanks of suitable capacity. Cleaning and rinsing stages can be of mild steel. Coating stage can be of heavy mild steel or stainless steel.
Chemicals required	"Permadiene" No. 1
Pre-cleaning methods	Any common degreasing method can be used. Alkali cleaning ("Ridosol"), Acid cleaning ("Deoxidine"), Emulsion-alkali cleaning ("Ridosol", "Ridoline"); vapor degreasing, solvent wiping, etc., are examples. Acid cleaning may need to follow other cleaning methods if rust or scale is present.
Bath Temperature	190° - 210°F.
Coating time	20 - 30 minutes
Coating weight range Mgs./Sq. Ft.	1000 - 4000
Technical Service Data Sheets	No. 7-20-1-2 T. M. No. 5



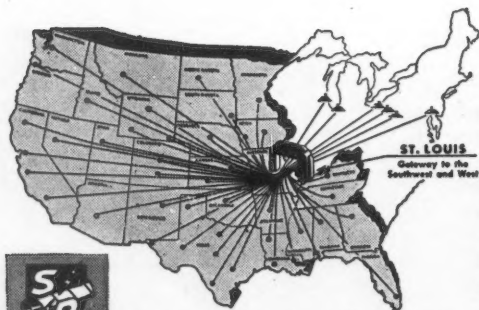
WRITE FOR FURTHER INFORMATION ON "PERMADINE"
AND YOUR OWN METAL PROTECTION PROBLEMS





Every step of processing your pipe is under control

- PIPE is warmed and dried to eliminate moisture before cleaning and priming.
- PRIMED PIPE is properly aged, and before coating and wrapping is warmed beyond the minimum temperatures required to obtain maximum bond of coating materials.
- APPLICATION TEMPERATURES of enamels are rigidly controlled, with mechanical agitation, to prevent alteration of softening points and penetrations.
- WRAPPING MATERIALS are stored in a specially constructed warm air conditioned room at constantly maintained temperatures to eliminate moisture before C/W.
- ELECTRICAL HOLIDAY DETECTION is made of every piece of C/W pipe, and repaired if necessary, to assure fulfillment of your specifications.



COATING AND WRAPPING-IN-TRANSIT

permits stop-off for processing or storage at St. Louis without freight penalty. When you ship through the St. Louis gateway, you enjoy "through freight rates" instead of the higher combination rates generally used.



standard pipeprotection inc.

3000 South Brentwood Blvd. • St. Louis 17, Missouri

New Products—

(Continued From Page 27)

Products Co., 2820 N. Fourth St., Philadelphia 33, Pa. is the manufacturer.

Porta-Brasive Blaster, a portable sand blaster in four sizes, a low-priced machine for cleaning paint, rust, scale or other material from surfaces is available from Pruden Tool Co., Inc., 310 West 68th St., New York 23, N. Y. The blaster, developed originally for use in automobile body shops, has found many uses where a small portable machine is needed. Illustrations of the machines, with descriptions of capacities and prices may be obtained on request.

Nylon powder, with a particle size below 10 microns, and suitable for cold pressing and sintering has been developed by the Polymer Corp., Reading, Pa. The material, known as Nylasint 66, will be marketed by National Polymer Products, Inc., Box 422, Reading, Pa. The material, basically the same as the FM10001 grade of nylon used in the molding industry, has somewhat lower toughness than the molded product. The powder also may be blended with a wide range of fillers. A technical bulletin is available.

Ricwilite 7100, a cold setting phenolic resin coating developed by Ric-Wil Plastic Coating & Mfg. Corp., 1290 Euclid Ave., Cleveland 15, Ohio, is described in an illustrated 4-page folder available on request.

Flared Tube Fittings of stainless steel are being made by the Special Screw Products Co., 5445 Dunham Road, Bedford, Ohio in any combination through one inch. This permits coupling different sizes of tubing without the use of reducers. Teflon ring seals are provided in the fittings.

Sealbrite CRC-55, a dry, thin waterproofing compound and rust preventive designed to give long term protection on all metals is announced by the London Chemical Company, 325 West 32nd St., Chicago 16, Ill. The material when deposited on metal is dry to the touch, non-oily and non-tacky, has excellent lubricating qualities and may be removed with any high flash solvent, the company says. It is claimed also the coating will not contaminate foods, has excellent resistance to high temperatures and good capillary features.

Tenite pipe manufactured by Parfrey Plastics Pty., Ltd., Australia is being used as water lines in highly corrosive soils which normally cause failure of metal lines in 12 months. Some of the pipe is buried and covered in one operation by attaching the end of a roll to the shaft of a mole plow. As much as 600 feet of 1-inch pipe have been installed in this way in a single run. The pipe also is used in bottling works to conduct fruit juices, and in dairies where lines are regularly cleaned with 150 degree hot water containing sodium hypochlorite. In Sydney, the pipe is being used for water service lines to houses.

Silicote, a silicon type water repellent for use on interior and exterior masonry surfaces has been developed by Wilbur & Williams Co., 130 Lincoln St., Boston 35, (Brighton) Mass.

~~ROST AND CORROSION~~

Wipe out these menaces efficiently and effectively with *Palladium[®] Mastics!*

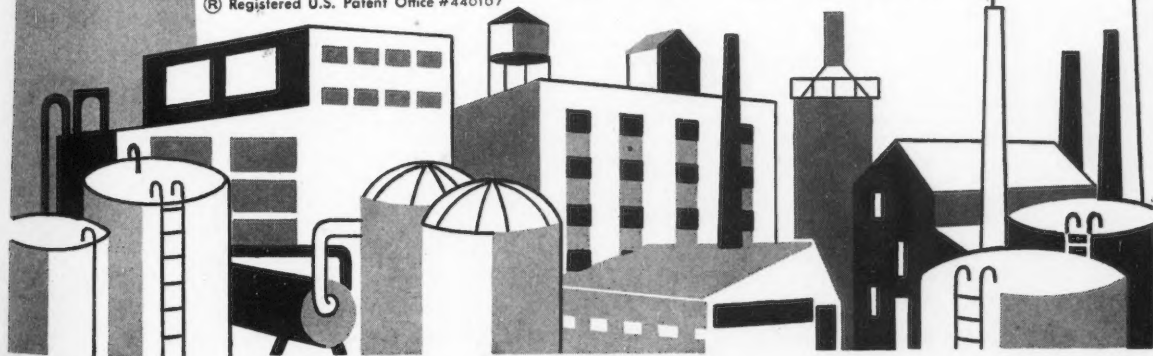
Here's why PALLADIUM MASTICS are specified where quality performance is essential:

- They are products of controlled manufacture and have been used successfully over a long period of years.
- They are highly resistant to acid and alkali and other corrosive fumes.
- PALLADIUM MASTICS are vapor-sealing.
- They give excellent performance even when applied under high humidity conditions.
- PALLADIUM MASTICS are effective on all types of metal surfaces.
- They remain firmly bonded to metal surfaces after application.
- PALLADIUM MASTICS are sufficiently flexible to expand and contract with the protected structure.
- Only one application is necessary as this is equivalent to 20 or more coats of paint.
- PALLADIUM MASTICS insulate as well as protect.

Palladium Mastic Corporation of America

ROCKEFELLER CENTER 620 FIFTH AVENUE NEW YORK 20, N. Y.

® Registered U.S. Patent Office #440107



PERSONALS

J. C. Matthews has been appointed sales representative for Protective Sales, Barrett Division, Allied Chemical & Dye Corp. Mr. Matthews was formerly a senior member of the Barrett Field Service Dept.

John Conroy, formerly sales representative of the Barrett Division, Allied Chemical & Dye Corp., is now sales manager of Rosson-Richards Co. Mr. Conroy assumed his new position last June.

E. M. Kline was made general manager of the Huntington, W. Va. Works of the International Nickel Co., Inc. Mr. Kline succeeded **Herman M. Brown** who retired. **G. K. Crosby** was appointed assistant general manager of the Huntington Works, succeeding Mr. Kline. The Huntington plant is the largest operated by the company in the United States.

C. E. Holmes will represent the Cincinnati Cleaning and Finishing Machinery Co., Ironton, Ohio, in the states of Alabama, Tennessee, Georgia, Louisiana and Mississippi. Mr. Holmes will maintain his office in Birmingham, Ala. He will sell the company's metal cleaning machines and finishing systems.

Pittsburgh Coke and Chemical Co. has announced the appointment of **H. F. Trusler, Jr.**, as technical sales representative, synthetic base coatings. He will direct and coordinate sales, production, technical service and development activities of synthetic coatings. He will be in the central office of the company in Pittsburgh, Penna.

Joseph A. Snook has been promoted vice-president in charge of sales for the Atlas Mineral Products Co., Mertztown, Penna. and Houston, Tex. His former position was secretary and purchasing agent. The Atlas Mineral Products Co., a large producer of corrosion resistant cements in the steel and process industries, also manufactures corrosion resistant coatings, linings and pipe jointing compounds.

Promotion of **Lee Fraser** to production manager of Arma Corp., Brooklyn and Mineola, N. Y. was announced recently. Mr. Fraser was formerly staff assistant to W. C. McAllister, vice-president, manufacturing. The Arma Corp. is a subsidiary of American Bosch Corp. The firm mass produces high precision electrical instrument components.

W. D. Adams was named West Texas zone manager for Tube-Kote, Inc. The Houston firm formulates and applies baked-on plastic coatings for tubular goods for the oil and chemical industries. Mr. Adams is a graduate petroleum engineer of Texas A & M College and has had prior oil field experience.

Arthur L. Harding, retired Chief Electrical Engineer of Ebasco Services, Inc., died May 2, near Casablanca, Africa, of a heart condition after a long illness. His death interrupted a tour of Europe and Africa. Born in 1888 in Boston, Mass., he graduated from Massachusetts Institute of Technology in 1910. He

joined Ebasco in 1916 and remained with the firm until his retirement in 1946. He was a member of the Masons, American Institute of Electrical Engineers, National Electric Light Association, Edison Electric Institute and the Association of Illuminating Companies. Mr. Harding is survived by his widow, Mrs. Marjorie C. Harding.

Dr. W. A. Koehler, of West Virginia University has assumed the position of director of the school's engineering experiment station. He is professor and head of the university's department of chemical engineering. He formerly served as acting director of the experiment station, the research agency for the College of Engineering and the School of Mines.

John W. Lohnes has been appointed vice president of sales for the Jeffers Electronics and Spear Resistor Divisions of Spear Carbon Co.

H. V. Beezley, a member of the NACE Shreveport Section, celebrated in June his 15th anniversary with the United Gas Pipe Line Co. Mr. Beezley is in the engineering department of the Shreveport General Office of United Gas.

E. J. Lickwar has been appointed sales representative in the Pittsburgh, Pa., area for Alloy Steel Products Co., Inc. Mr. Lickwar replaces **Herbert V. Evans, Jr.**, who was recently made district manager for Alloy Steel Products Co., Wilmington, Del.

R. M. Barrick and **R. J. Mott** (with the Keystone Steel & Wire Co.) have received transfer-promotions. Mr. Barrick has been transferred to the West Texas-New Mexico territory, to replace **F. C. McKnight**, who died recently. Mr. Mott replaces Mr. Barrick in the Kansas-Oklahoma area.

Walter Sokolofsky has been appointed foundry service engineer for Monsanto Chemical Company's Plastics Division. Mr. Sokolofsky has been assigned to assist foundries in developing the application of the new shell molding process.

P. M. Buhner and **C. O. Kleinsmith** have been appointed executive vice-presidents of National Carbon Co., a Division of Union Carbide and Carbon Corp. Both Mr. Buhner and Mr. Kleinsmith have been with National Carbon Company for many years. Mr. Buhner having been associated with research and development activities and Mr. Kleinsmith with sales.

D. F. Bradley has been appointed manager of the Detroit district sales office for Shell Chemical Corp. He succeeds **W. E. Keegan**, who has been appointed to the position of Assistant to the Vice-President, Marketing. Mr. Bradley was formerly stationed in New York as manager of the Solvents department of Shell Chemical's Eastern Division. Before that he was technical salesman for Shell Chemical in the Detroit office.

H. H. Anderson, who retired August 2 as vice-president and general manager of Shell Pipe Line Corporation has accepted the position of vice-president and general manager of Trans-Mountain

Pipeline Company, a Canadian firm now building a 24-inch line 711 miles from Edmonton, Alberta to Vancouver, B. C. Mr. Anderson, long active in affairs of the American Petroleum Institute and the National Association of Corrosion Engineers, was for several years chairman of the NACE's membership control committee and was personally responsible for the rapid increase in the number of corporate members of the association. He also served one term as vice-president. Mr. Anderson joined Shell in 1917 in California, and was identified with the construction of Shell's San Francisco office building, and many of Shell's pipe line installations.

Ralph C. Gough has been appointed special representative of Joseph Dixon Crucible Co., Jersey City, N. J. in the New England area.

Richard H. Shaffner has been named sales engineer for Prufocoat Laboratories, Inc., Cambridge, Mass. He formerly was with Hooker Electrochemical Co. He lives at Niagara Falls, N. Y.

Charles G. Gribble, Jr. has been named manager of sales for Houston Division, Metal Goods Corp. Mr. Gribble, a graduate of Stephen F. Austin College, is a member of NACE and of the American Society for Metals.

J. Harry Fenton, representative of Brance-Krachy Co., Inc. collapsed July 17 and died almost immediately. Wayne Broyles, of Brance-Krachy was with Mr. Fenton when he died. He was a member of NACE.

Frank N. Speller has become an associate member of Management Consultants, Inc., business consultants, 37 Wall St., New York.

William A. Johnson has been named chairman of the board of Amercoat Corp., South Gate, Cal. He formerly was president. **Alan E. Turner**, formerly executive vice-president has been named president.

Walter S. Schamel has been appointed district manager of the Los Angeles office for American Wheelabrator and Equipment Corp. His new offices will be at 3155 Leonis Blvd., Vernon, Los Angeles 58.

Edward H. Platz, Jr. has been assigned to the Nickel Section of the Ferro-Alloys Branch, National Production Authority. He is expected to return to Lebanon Steel Foundry, Lebanon, Pa. in six months.

J. M. Selden has been named manager of the Eastern Division of Shell Chemical Corp.

R. F. Brown has been appointed assistant salesmanager in Carbide and Carbon Chemicals Company's Industrial Chemicals Division.

Lamont du Pont, former president of E. I. du Pont de Nemours & Company died July 24 at the age of 71.

C. Manning Davis has been appointed head of the Analytical Section of the International Nickel Company's Research Laboratory at Bayonne, N. J.



Corrosion Abstracts

Index To CORROSION ABSTRACTS

Vol. 8 September, 1952 No. 9

	Page
2. TESTING	
2.2 On Location Tests	257
2.3 Laboratory Methods	259
3. CHARACTERISTIC CORROSION PHENOMENA	
3.6 Electrochemical Effects	262
3.7 Metallurgical Effects	262
4. CORROSIVE ENVIRONMENTS	
4.2 Atmospheric	264
4.6 Water and Steam	264
5. PREVENTIVE MEASURES	
5.2 Cathodic Protection	264
5.3 Metallic Coatings	266
5.4 Non-Metallic Coatings and Paints	268
8. INDUSTRIES	
8.1 Group 1	270
8.2 Group 2	272
8.3 Group 3	272
8.4 Group 4	272
8.8 Group 8	273

Investigate Other Abstract Services Offered by NACE!

Abstract Punch Card Service.

Corrosion abstracts printed on McBee Punch Cards, pre-indexed by the NACE Filing system with up to 4 cross-references. Write for full information.

Bibliographic Surveys of Corrosion.

Abstracts in book form. Indexed and cross indexed by topics. Author Index. A valuable aid for corrosion workers. See advertisement this issue for added information.

NATIONAL ASSOCIATION of CORROSION ENGINEERS

1061 M & M Bldg. Houston, Texas

2. TESTING

2.2 On Location Tests

2.2.5, 5.4.5

A Series of 1000-Hour Saltfog Exposure Tests of Lithopone-Alkyd Paints Having Different Extenders. M. KRONSTEIN AND G. MACNIECE. *Tech. Bull. No. 5*, Nov. 1950. Wet Ground Mica Assoc., Inc., New York.

The tests were made on paints pigmented with lithopone mixed with the following extenders: 5 wet ground micas; 3 different mica-like materials; magnesium silicate; barites; calcium carbonate; calcium sulphate; 2 different silicas; and whiting. A control paint with no extender was also included. The panels were of clean steel. Graphs show the degree of failure of the paints after different periods of exposure to the test. It is evident that extenders influence the behavior of the paint considerably, and that micas are among the most useful. —ZDA.

2.2.5, 5.4.5

Outdoor Exposure Results on Clear and Pigmented Films at Six Months. Cincinnati, Dayton, Indianapolis and Columbus Paint and Varnish Production Club. *Paint, Oil, Chem. Rev.*, 113, No. 24, 120-123 (1950); *Official Digest Federation Paint & Varnish Production Clubs*, No. 311, 1033-1041 (1950).

Twenty-three film-forming liquids, pigmented and unpigmented, coated on to glass panels, were exposed to natural weathering for 6 months. The liquids were: varnish linseed oil, dehydrated castor oil, a commercial alkyd, trilinolein, pentaerythritol linoleate, trilinole-

Sources of

PHOTOPRINTS

and/or

MICROFILM COPIES

of Technical Articles Abstracted in

CORROSION ABSTRACTS

ENGINEERING SOCIETIES LIBRARY,
29 West 39th Street, New York 18,
N. Y.

CARNEGIE LIBRARY OF PITTSBURGH,
4400 Forbes St., Pittsburgh 13, Pa.
NEW YORK PUBLIC LIBRARY, New
York City.

U. S. DEPT. OF AGRICULTURE
LIBRARY, Office of Librarian, Wash-
ington, D. C. (Special forms must be
secured).

LIBRARY OF CONGRESS
Washington, D. C.

JOHN CRERAR LIBRARY
86 East Randolph St.,
Chicago 1, Ill.

Persons who wish to secure copies of articles when original sources are unavailable, may apply directly to any of the above for copies. Full reference information should accompany request. The National Association of Corrosion Engineers offers no warranty of any nature concerning these sources, and publishes the names for information only.

NACE will NOT accept orders for photoprint or microfilm copies of material not published by the association.

CODE OF AGENCIES SUPPLYING CORROSION ABSTRACTS

AER—Aeronautical Engineering Review, Institute of Aeronautical Sciences, Inc. 2 East 64th St., New York 21, N. Y.

ALL—The Abstract Bulletin, Aluminum Laboratories, Ltd. P. O. Box 84, Kingston, Ontario, Canada.

AWWA—Journal, American Water Works Association. Amer. Water Works Assoc., 521 Fifth Ave., New York 17, N. Y.

BL—Current Technical Literature, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

BLR—Battelle Library Review, Battelle Memorial Institute Library, 505 King Ave., Columbus, Ohio.

BNF—Bulletin; British Non-Ferrous Metals Research Association, 81-91 Euston St., London NW 1, England.

CALCO—Calco Chemical Division, American Cyanamid Corp., Bound Brook, New Jersey.

CE—Chemical Engineering, McGraw Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

CEC—Consolidated Edison Co. of New York, Inc. 4 Irving Place, New York 3, New York.

EL—Electroplating, 83/85 Udney Park Road, Teddington, Middlesex, England.

EW—Electrical World, McGraw-Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

GPC—General Petroleum Corp. of California, 2525 East 37th St., Los Angeles 11, Calif.

INCO—The International Nickel Co., Inc. 67 Wall Street, New York 5, New York.

IP—Institute of Petroleum, 26 Portland Place, London W1, England.

MA—Metallurgical Abstracts, Institute of Metals, London, England. 4 Grosvenor Gardens, London SW 1, England.

MI—Metallurgia Italiana. Associazione Italiana di Metallurgia. Via S. Paola, 10, Milano, Italia.

MR—Metals Review, American Society of Metals. 7301 Euclid Ave., Cleveland 3, Ohio.

NALCO—National Aluminate Corp. 6216 West 66th Place, Chicago 38, Illinois.

NBS—National Bureau of Standards. Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C.

NSA—Nuclear Science Abstracts. United States Atomic Energy Commission, Technical Information Division, Oak Ridge, Tenn.

PDA—Prevention Deterioration Abstracts. National Research Council, 2101 Constitution Ave., Washington 25, D. C.

RA—Refrigeration Abstracts, American Society of Refrigeration Engineers. 40 West 40th St., New York 18, N. Y.

RM—Revue de Metallurgie, Paris, France. 5 Cite Pigalle, Paris (9e), France.

RPI—Review of Current Literature Relating to the Paint, Colour, Varnish and Allied Industries, Research Association of British Paint, Colour & Varnish Manufacturers, London. Waldegrave Rd., Teddington, Middlesex.

TDD—Technical Data Digest, Air Material Command—Technical Service Section, Central Air Documents Office, Wright-Patterson Air Force Base, Dayton, Ohio.

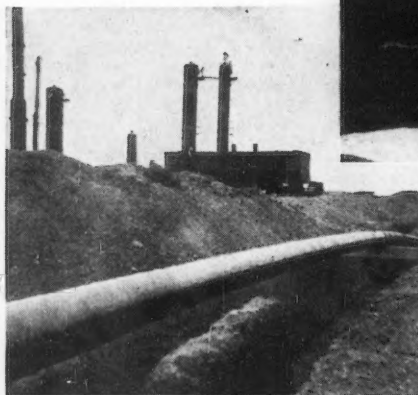
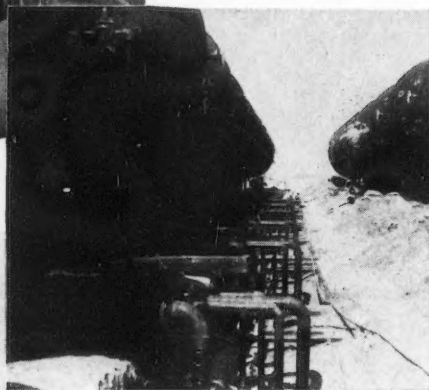
TIME—Transactions of Institute of Marine Engineers. 85 The Minories, London EC 3, England.

UOP—Universal Oil Products, 310 South Michigan Ave., Chicago, Illinois.

ZDA—Zinc Development Association. Lincoln House, Turl Street, Oxford, England.

TAPECOAT*

...Your first line of defense against
Corrosion on Pipe, Pipe Joints,
Couplings
and Tanks



*Reg. U. S. Pat. Off.

Underground or above ground, TAPECOAT withstands severe corrosive attack. Over the past 11 years, this original coal tar protection in handy tape

form has proved its dependability in guarding against moisture, acids, alkalis, chemical fumes and other severe conditions. As your first line of defense, TAPECOAT assures greater protection, reduces maintenance and cuts pipe replacement cost.

TAPECOAT is quick and easy to apply with the use of a torch to bleed the coating and insure a perfect bond. It is sized to the job in widths of 2", 3", 4", 6", 18" and 24". Wrapping is done spirally with widths up to 6", and "cigarette-wrapped" in the larger sizes.

Write for full details and prices.

The TAPECOAT Company

Originators of Coal Tar Tape Protection

1521 LYONS STREET, EVANSTON, ILLINOIS

nin, tri- α -elaeostearin, pentaerythritol oleate, α -elaeostearate and linolenate, di-pentaerythritol oleate, linoleate and linolenate, long- and short-oil alkyds (glycerol-based with linoleic, linolenic and elaeostearic acids, separately, in the acid component for both short- and long-oil alkyds and pentaerythritol-based with linoleic and linolenic acids in the acid component for the long-oil alkyds and with oleic acid in both short- and long-oil alkyds). Pigmentation was with a mixture of titanium dioxide 75 percent and acicular, lead-free zinc oxide 25 percent, at a pigment vol. concn. of 30 percent. The appearance of the films after exposure is described. No definite conclusions can be made as yet as to the relative weathering properties of the paints.—RPI.

2.2.5, 5.4.5

Effect of Wind on Paint and Other Protective Coatings. K. WURTH, *Lack- u. Farben-Chem.*, 4, No. 4, 58-60; Nos. 5 & 6, 82-85 (1950).

Wind may carry rain, hail, sand, salt spray, corrosive gases, etc., and thus accentuate paint breakdown. The incidence of breakdown depends on aspect with respect to prevailing winds and the degree of shielding by the mass of the building concerned. Paint failure on the exterior walls of blocks of flats and wind patterns over model buildings are illustrated.—RPI.

2.2.5, 5.4.5, 8.4.5

Service (Abrasion) Testing of Selected Protective Coatings. C. D. WARSON AND G. A. WEST, *Oak Ridge National Laboratory*, Dec. 11, 1950. 12 p. (ORNL-868).

Thirteen paints and three strippable coatings which were outstanding in corrosion-resistance and decontamination studies have been subjected to service wear tests to further define their usefulness. The relative resistance to heavy foot and light vehicle traffic is presented, and certain coatings are recommended for use in radiochemical facilities.—NSA.

2.2.7, 4.6.11, 6.2.5, 6.3.10

Report on Specimens Removed from Sea Water Tests at Kure Beach, N. C., May 1949. International Nickel Co., Inc., Development & Research Division, New York. October 1950. 30 l., illus., tables, diagr.

Effects of minor constituents on sea water corrosion of 70:30 copper-nickel alloy: Alloys containing various percentages of zinc, iron, manganese, tin, chromium, and arsenic were exposed for approximately 10 years at a depth of 3-4 feet in sea water flowing at a velocity of 1-2 fps. Corrosion rates measured by weight loss and pitting, decreased considerably with prolonged exposure, regardless of minor constituents present. Zinc had little effect on weight loss but tended to aggravate pitting of iron-modified alloys; the zinc content should be kept at or below 0.5 percent. Manganese was slightly beneficial, especially in reducing pitting, in alloys in which the zinc content did not greatly exceed the iron content. The main action of tin was to suppress a detrimental effect of 1 percent zinc.

Zinc-coated steel: The life of a hot-dipped zinc coating was approximately 1 year per ounce of coating weight when immersed in sea water flowing at a rate of 1-2 fps.

Behavior of Hastelloy C: In similar

sea water exposures up to 10 years Hastelloy C, like Hastelloy A and B corroded less in the rolled and sand-blasted conditions than in the cast and ground conditions. Neither type specimen showed any pitting or crevice corrosion under bakelite washers used to insulate samples from the exposure rack.

Sea water tests on Stellite: Specimens immersed under similar flow conditions for approximately 7 years showed crevice corrosion. Stellite was much less susceptible to pitting than to corrosion, but corroded slightly faster in the ground state than in the as-rolled condition with scale present.

Sea water tests on Ilium: In 5-year sea water exposure, Ilium G corroded faster than Ilium R, but did not pit. Ilium R exposed without removing the hot rolling scale pitted on the surface at breaks in the oxide scale. This was probably caused by local galvanic action at the breaks with the scale being cathodic to the base alloy. Both this sample and a pickled Ilium R sample corroded under the bakelite washers.

Behavior of Zincate in sea water: Steel panels with four different Zincate coatings were exposed approximately 1 year at a depth of 3-4 feet and a flow rate of 0-4 fps. The Zincate treatments did not prevent fouling but did reduce the corrosion rate considerably.

Behavior of low-alloy chromium and chromium-aluminum steels with various surface treatments: Painted and unpainted steels were passivated by immersing them in concentrated nitric acid for 5-6 minutes at room temperature, rinsing, immersing 10-15 minutes in boiling 3 percent potassium chromate -0.5 percent disodium phosphate solution, and drying. The treatment did not improve the corrosion resistance of the steels when exposed 2 years to quiet sea water. One coat of Bitumastic B50 paint applied cold was beneficial. The four low-alloy steels tested, viz., two French steels, one containing 2 percent chromium and 1 percent aluminum, the other containing 3.7 percent chromium and 1.3 percent aluminum; and two American steels containing 3 and 5 percent chromium, respectively, corroded in about the same way, all being superior to a killed carbon steel control.

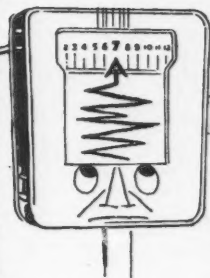
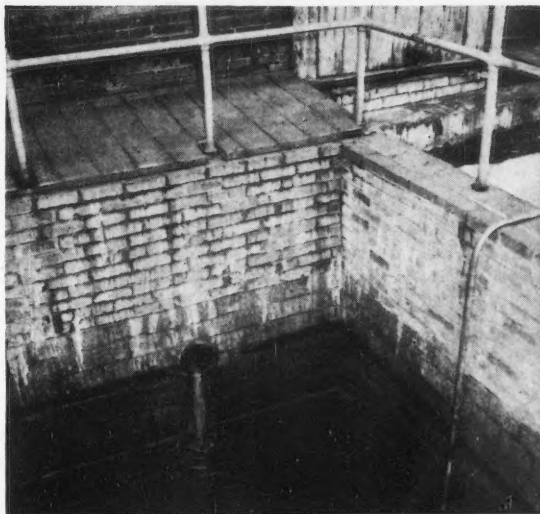
Behavior of titanium-nickel-cobalt-silicon alloys in sea water: Ti-Ni-Co-Si No. 10 and No. 54 corroded to about the same extent during a 1.5-year exposure in quiet sea water. One specimen of the No. 54 alloy started to corrode around the edges and the other suffered severe attack on the surface, probably because of poor insulation at the fastening.—PDA.

2.3 Laboratory Methods

2.3.2, 6.3.6, 4.6.5, 4.6.6

Study in the Corrosion of Metals Occasioned by Aqueous Solutions of Some Surface-Active Agents. I. Copper. H. HOLNESS AND T. K. ROSS. *J. Appl. Chem.*, 1, Pt. 4, 158-169 (1951) Apr.

Action of dilute aqueous solutions of representative anionic, cationic and non-ionic wetting agents on sheet copper was studied. Three types of water were used: London tap-water, distilled water and tap-water softened by the zeolite base-exchange process. The effects of varying the pH of the solutions from 2-12 and of temperature changes were



When the pointer can't make up its mind...specify → **Pennsalt Furan Cement** for your corrosion-proof mortar

If you are the process engineer in a typical chemical unit, facing alternate acid-then-alkaline conditions, then you want to know how best to handle *both* in corrosion-proof equipment.

The answer is Pennsalt Furan Cement mortar, according to many other plants who have this same problem. Matter of fact, we use it ourselves in our own plants which make everything from household lye to elemental fluorine. And here's why Pennsalt Furan Cement gets the nod:

- Resistant to alkalis, most acids, solvents, greases, organics, salts ... to temperatures of 350-375°F.
- Forms dense, hard, non-porous mortar with excellent abrasion resistance and adhesion.
- Permits narrowest practical widths of joints.
- Longer-than-average working time, easier handling.
- Chemical setting, allowing hardening in confined areas.
- Stable—won't freeze in winter or become viscous in summer.
- Non-toxic, not conducive to dermatitis, not a fire hazard. Contains no vaporizing solvent.

As you know, users of Pennsalt Cements gain the added benefit of Pennsalt's Corrosionproofing Service—built around many years of hard-bitten experience in applying corrosion-proof materials in severe chemical environments. Why not write and find out how Pennsalt Furan Cement may answer a corrosion problem of yours? Corrosion Engineering Products Dept., Pennsylvania Salt Manufacturing Co., Philadelphia 7, Pa.



investigated. Most of the anion-active agents examined, first coated the copper with a water-repellent film which afforded protection to the metal. With the cationic agents no water-repellent film was formed and only triethanolamine attacked the copper to any extent. There was no obvious action with the non-ionic agent. In general, rise of temperature caused increased attack, but changes in pH of the solutions were without marked effect on the course of the corrosion. Results are expressed graphically. 32 references.—INCO.

2.3.3, 1.2.5

Colonial Insecticides, Fungicides and Herbicides Committee—Third Annual Report, 1949-50. Colonial Research, 1949-50, H.M.S.C., 1950, 125-149.

Surface crystallization of D.D.T. (necessary for high toxicity) from plastic films of methyl methacrylate polymer and chlorinated rubber occurs only within a limited range of ratios of plastic, plasticizer and insecticide. Urea formaldehyde resin is the most promising medium for insecticidal surface coatings. Crystallization of D.D.T. takes place on the surface of the resin at a concentration of 20 percent.—RPI.

2.3.5, 3.5.9

Potentials Set Up by Thermal Gradients in Iron Immersed in NaCl Solutions. HERBERT H. UHLIG AND OSCAR F. NOSS, JR. Paper, 6th Annual Conference, Nat'l Assoc. Corrosion Engrs., St. Louis, Mo., April 4-7, 1950. *Corrosion*, 6, No. 5, 140-143 (1950) May; discussion, *Ibid.* 6, No. 9, 320 (1950).

The relative damage caused by galvanically coupling a piece of iron at high temperature to another piece at low temperature in an electrolyte is a question of practical importance. Combinations of this kind occur in designs of industrial equipment such as condenser tubes, water-cooled radiators, boiler tubes, stills, pasteurizing equipment, etc.

A laboratory study of cells in which seamless-steel tubing electrodes were immersed in sodium chloride solutions, with one electrode at 100° C. and the other at 25° C., revealed that: 1) The potential difference in 3 percent NaCl under specific conditions of aeration and stirring is 0.024 volt, with the hot electrode the anode. 2) Decrease of aeration, stirring, or NaCl concentration decreases the measured potential difference. 3) The short-circuit current in 3 percent NaCl amounted to 0.00043 ampere per square inch, equivalent to an anodic corrosion rate of 0.03 ipy. In nitrogen saturated solution, this current falls to zero. 4) The short-circuit current is limited apparently by polarization of the cathode rather than resistance of the electrolyte between 0.125 percent and 3 percent NaCl. It appears that the iron electrode at 100° C. as sacrificial anode will cathodically protect iron at 25° C. of equal area to which it is coupled in 3 percent NaCl solution.

2.3.7

Load Capacity of Lubricants. V. H. BRIX. *J. Inst. Petroleum*, 36, 295-302 (1950) May.

The demands for lubricants with great chemical stability and resistance to oxidation at high and low temperatures, low volatility, and high viscosity index have been met by solvent-refined oils which have qualities formerly only pos-

sessed by the paraffinic oils of the eastern U. S. This improvement in the standard of oils has allowed engine builders to obtain higher b.m.e.p.'s and to produce hotter, more highly stressed, and more efficient power units than formerly. The same oils have, therefore, been called upon to endure the greater severity of loading conditions especially manifest in components such as gears and cams. Oils are now critical to sliding conditions between such members, and their essential lubricating value is the predominant property called into play. Solvent-refined mineral oils, without additives, are often found deficient in this property, with the result that 'scuffing' occurs, a form of welding and surface damage which produces rapid deterioration of moving parts. Unfortunately, the ability of an oil or lubricant to prevent 'scuffing' is most difficult to measure. Whereas chemical stability can to a large extent be covered by precise specifications, the most intrinsic property of oils, their ability to lubricate, still remains undefined and there is not even a proper name for it. Such things as corrosion, gumming, etc., are all well understood, in principle if not in detail, but no general mechanism has been revealed which can explain why one liquid remains trapped between moving surfaces, whilst another fluid with similar physical properties is squeezed out and allows them to scuff or to seize. 'Lubricating value', 'film strength', 'oiliness', etc., all synonymous terms, must therefore be assessed directly by squeezing the lubricant between loaded surfaces in relative motion and determining how much of this treatment each lubricant can stand without the metals being damaged. Many testing machines have been evolved to rate lubricants in this manner, notably the types in which a flat metal surface is pressed on to the periphery of a rotating disk. Quite considerable instability seems to be the feature of such tests, which embody a condition never occurring in practice, namely pure sliding motion with line or point contact. It follows that a feature most desirable in an oil-testing machine is the combination of rolling motion with sliding. If the aforementioned type of test machine, in which a rotating disk rubs against a stationary plate, is modified and a rolling motion imparted to the system, the action between gears and cams is simulated, and the rubbing action distributed over a wide area of both surfaces as the point of contact now moves relatively to both. The actions are therefore not concentrated at one line of contact (or indeed one point of contact as is the case in test machines in which steel balls rub together). In the Roll-Slide machine described by the author, this aim is achieved by using a design in which a plate bears against a disk which rotates and oscillates at the same time. The plate is loaded against the disk by means of a self-aligning feature, allowing the test surface to be unaffected by deflexions in the machine.—TIME.

2.3.7, 5.3.4

The Nodule Method of Measuring the Adhesion of Electrodeposited Coatings. ABNER BRENNER AND VIRGINIA D. MORGAN, U. S. National Bureau of Standards. *Proc. Am. Electroplaters' Soc.*, 37, 51-67 (1950).

Adhesion of an electrodeposit to basis metal is an important factor in serviceability of a coating. A newly developed

method for measuring this adhesion involves electroforming of an adherent mushroom-shaped cobalt nodule on surface of coating to act as a grip for applying a detaching force. This method has several advantages over other procedures: It is the only general method capable of measuring adhesion of coatings of commercial thickness, e.g., as thin as 0.0005 in.; no specially shaped test pieces are needed; no machining operations or expensive testing machines are required; results are expressible in terms of ordinary mechanical units; and no soldering is necessary, thus avoiding the heat of soldering which can alter adhesion of a coating. The method, however, cannot yet be applied to commercially plated items. One difficulty is that the nodule does not adhere to a bright nickel coating.

Procedure consists of 1) masking surface of the metal with a rack-coating lacquer and defining, by means of a hole in a plastic disc or washer, several areas approximately 0.0625 in. in diameter upon which the nodules are to be built. Washers are placed on the surface of the lacquer before it dries. 2) The small circular area that is to receive the nodule is cleaned, electrically etched, and given a cobalt strike for 3 minutes in either a solution containing per liter 25 g cobalt chloride ($\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$) at pH 0.5, or a solution comprising 100/g cobalt chloride in one liter 10 percent hydrochloric acid. The current density used is 0.5 asi. 3) A nodule is then built by a molar solution of cobalt chloride at 167° F. and a pH of 4-5, containing 0.5 g per liter of a sulfonated-aryl type wetting agent. The strongest and most regularly shaped nodules are obtained by plating overnight at a current density of 0.13 asi. 4) The washer is removed and the nodule is gripped by a chuck and detached by exerting a force through a spring balance. The nodule detaches the initial coating, occasionally along with some of the basis metal if the degree of adhesion is high. The degree of adhesion is calculated in pounds per square inch.

Validity of the method was established by comparing tensile pull required to detach nodules that ruptured the basis metal with tensile strength of the basis metal. Forces of detachment for various basis metals were in about the same relative order as tensile strengths of the metals and of the right order of magnitude. Precision of the method was ± 15 percent for a 4-in. square specimen from which six to twelve nodules were pulled. The variation, however, was larger between individual specimens because surface conditions cannot be reproduced exactly. For practical purposes a highly precise method is not necessary; the order of magnitude of the adhesion is sufficient. Difference between forces of detachment required for a coating 0.0005 in. thick and one 0.003 in. thick were within the limits of reproducibility.—PDA.

2.3.7, 6.3.10, 4.3.5

Constitution Diagram of the Ni-O System and Physicochemical Nature of the Solid Phases in This System. (In Russian.) D. P. BOGATSKII. *J. Gen. Chem. (Zhurnal Obshchei Khimii)* (USSR), 21, No. 83, 3-10 (1951) Jan.

The above was investigated by different methods of physicochemical analysis. Certain equilibria of processes of dissociation, reduction, and oxidation in this system were also studied, and thermodynamics of such equilibria deter-

Write for Rates, 1061 M & M Bldg.
Houston 2, Texas

CORROSION DIRECTORY

Over 4600 Paid
Readers Monthly

CORROSION ENGINEERING

Let us select and apply the coating or lining best suited to protect your equipment and structures.

A & P FINISHING & MFG. CO.
17760 Clarann Avenue
Melvindale (Detroit) Mich.

ALL-CO
CATHODIC PROTECTION

Design • Installation • Surveys
Equipment • Supplies

ALLEN CATHODIC
PROTECTION CO.

P. O. Box 386 Phone EDison 2081
HARVEY, LOUISIANA

Dependable Selenium Rectifiers
for Cathodic Protection

are manufactured by

Richardson-Allen Corporation

a manufacturing affiliate of

WESLEY BLOCK AND COMPANY

39-15 MAIN STREET, FLUSHING, NEW YORK
IN CANADA: Richardson-Allen of Canada, Ltd.,
370 Victoria St., Toronto, Ontario

Cathodic Protection Service

Engineering - Installation - Surveys
Material - Supplies

Everything in the Cathodic Protection Field from
an Insulating Washer to a Turnkey Contract
Installation

4601 Stanford - HOUSTON - Phone JA 5171
NEW ORLEANS TULSA
1639 Robert St. 310 Thompson Bldg.
Phone CH-8310 Phone 2-9357

INSTRUMENTS

For the Corrosion Engineer

- Copper Sulfate Electrodes
- Resistivity Rod & Pipe Prod
- AC Bridges
- No Current Potentiometer with
Current Ranges

J. L. COLLINS
ANGLETON, TEXAS

CORROSION ENGINEERING

SURVEYS • DESIGNS • SPECIFICATIONS

Impartial Evaluation

THE HINCHMAN
CORPORATION

Francis Palms Bldg., Detroit 1, Mich.

CORROSION SERVICE LIMITED
Offers in CANADA

A Complete Service in Corrosion Engineering,
Design and Installation of Cathodic Protection
Systems.

Resistivity and Electrolysis Surveys.
Selection and Application of Protective Coatings.
Rectifiers — Anodes — Materials

77 York St., Toronto, Canada

SERVING ALL PIPELINES

PIPELINE ASBESTOS FELT

Made by The Ruberoid Co.

COAL TAR ENAMEL COATINGS

Made by Pittsburgh Coke & Chem. Co.

PERRAULT GLASS PIPE WRAP

Made by Perrault Glass Fiber Corp.

"Steve" Day

S. D. DAY COMPANY

1973 W. Gray Houston 19, Tex.

Phone JU-2431

CARL G. DEUBER

Technical Services in

Prevention of Deterioration

Anaerobic Corrosion

Fungus Inertness Tests of Pipe Coatings -
Wrappers - Tapes

Laboratories

114 East 32nd Street Telephone:
NEW YORK 16, N. Y. LEXington 2-3244

CATHODIC PROTECTION

Surveys Engineering
Installation Maintenance

Electro Rust-Proofing Corp.
(N. J.)

BELLEVILLE 9, NEW JERSEY

Atlanta - Chicago - Dallas - Monrovia

• Complete

CATHODIC PROTECTION

Systems . . . supplies . . . service
for special applications; water tanks
and pipe lines.

HARCO CORPORATION

16901 Broadway Cleveland, Ohio

Cathodic Protective Systems
Designed and Installed

Coating and Laying Specifications;
Corrosion Surveys; Consultation On
All Types of External Pipe Line Corrosion.

Huddleston Engineering Co.

Bartlesville Oklahoma

Complete Corrosion Mitigation
Product and Equipment Line
WE REPRESENT: Koppers Coatings, Nicolet
Asbestos Pipe Line Felts, Apex Magnesium
Anodes, National Graphite Anodes, Tapecoat.

• Rectifiers • Instruments

and other nationally known products

MIDDLE WEST COATING & SUPPLY

TULSA, OKLA.

207-A Daniel Bldg. Phone: 2-5215

PIPE COATING "KNOW-HOW"

by PIPE PROTECTION SERVICE, Inc.

Modern Portable Railroad

Equipment for Any Size Pipe or Job

Main Plant: 179 FRONT ST., ELIZABETH, N.J.

"The Complete Coating Service"

PLASTIC ENGINEERING SALES CORP.

Quality Products for Corrosion Control

PESCO

- Fiberglass Molded Ring Seal Gaskets
- Armored Nylon Insulating Coupling
- Plastic Corrosion Protection Pipe Coatings
- Tapester Pipe Wrapping Machines

Telephone PE-5136

P. O. BOX 1037 FORT WORTH, TEXAS

RIO ENGINEERING CO.

Cathodic Protection Systems

Surveys Installation Design

HOUSTON, TEXAS
3607 Yaakum KE 9792

South Florida Test Service

INSPECTION - TESTING - RESEARCH

ENGINEERS

(Established 1931)

Corrosion, weathering and sunlight tests.
Four locations in Southern Florida for inland,
salt atmospheric, tidalwater and total immer-
sion exposure tests.

4201 N. W. 7th St. MIAMI, FLORIDA

WATER SERVICE LABORATORIES, INC.

Specializing Since 1927

Water treatment for corrosion
control in buildings, boilers and
air conditioning systems.

Main Office—423 West 126 Street, NYC
Offices also in Phila. and Wash., D. C.

CORROSION-PROOF

• TANKS, FLOORS, FUME DUCTS
AND PROCESS EQUIPMENT
• COMPLETE LINE OF
PROTECTIVE COATINGS..

Over a Quarter Century of Experience

CORROSION-PROOF
MATERIALS - CONSTRUCTION - SUPERVISION

The CEILCOTE Co. 4832 RIDGE RD.
CLEVELAND 9, OHIO

Pipeline Maintenance

Again in 1952, we lead all contractors in
Magnesium Anodes installed

LET US SHOW YOU WHY

► CATHODIC PROTECTION ► INSTALLATION
► ENGINEERING - SURVEYS
(Complete job or installation only)

Pipeline Maintenance CORPORATION
28126 TULSA, OKLAHOMA BOX 1428

IT'S NO ACCIDENT!

CORROSION Circulation Has
Increased 18% First Six Months
of 1952 over Average for 1951!

mined. A constitution diagram of the system is presented. 18 references.—BLR.

2.3.9

Scientists Develop New Technique for Studying Corrosion. *Elec. Eng.*, 70, No. 4, 370 (1951) Apr.

The new method is similar to television scanning and can be used for detection, study, recording, and analysis of corrosion phenomena. It can be measured as it takes place, regardless of the metal involved. By studying the action of the electric cells that cause corrosion, electro-chemists can learn more of the fundamental facts. The laboratory sample on which corrosion occurs is a metal cylinder. It is dipped in corrosive solution such as sea water, rotated several hundred times a minute, and scanned with a stationary probe electrode. The probe electrode, which is a plastic arm containing 11 silver wires, is placed about 0.02 inch away from the submerged cylinder. It picks up the minute electric currents, caused by corrosion and enables scientists to measure and study the process. These tiny currents can be amplified and viewed on an oscilloscope screen or photographed for later analysis. This method permits easier and faster study of the entire surface area of the corrosion sample. The new technique can be used for investigations of cathodic protection, corrosion inhibitors, stress corrosion and in fundamental corrosion studies.—INCO.

2.3.9, 6.4.2, 3.4.7

Polarographic Study of Corrosion Phenomena. Aluminum and its Alloys. JOHN M. MCGEE AND PIERRE VAN RYSELBERGHE, University of Oregon. Office of Naval Research Contract N6-onr-218, T. O. 1 June 1949.

Pure aluminum and representative aluminum alloys were exposed to aqueous saline solutions buffered to various pH levels and containing dissolved oxygen, carbon dioxide, hydrogen peroxide, hydrogen ion, or mixtures of these. The course of the reaction was followed by polarographic analysis.

In solutions more alkaline than pH 9, pure aluminum and each of the alloys tested reduced quickly any free oxygen or hydrogen peroxide. In solutions more alkaline than pH 10, hydrogen gas formed slowly on the alloy surfaces, and corrosion occurred whether or not oxygen was present. In solutions of pH 5-8 the metals reacted only slightly with free oxygen, and practically not at all with hydrogen peroxide. In buffers more acid than pH 4, reaction between free oxygen and metal increased with increasing acidity. Of the alloys tested, 4S-H34 was the most resistant to corrosion by oxygen in neutral or acid buffers, and alloys 24S-T3 and 75S-T6 were the least resistant.

The similarity of the reactions of aluminum alloys with hydrogen peroxide and with free oxygen in the buffer solutions support the assumption that hydrogen peroxide is a first product of the reduction of dissolved molecular oxygen.

Carbon dioxide alone or with hydrogen peroxide in neutral salt solutions or in buffers of pH 5.2-3.4 showed no measurable reaction with aluminum or its alloys, although the combination of these two agents in known to be very corrosive to iron, steel, and zinc.

In solutions of hydrogen ion, pure and commercial 2S aluminum showed

greater corrosion resistance than the rest of the alloys studied. Adding 1 percent or more magnesium, manganese, or zinc rendered aluminum alloy vulnerable to acid attack, particularly when 1 percent or more copper was also present.

The alloys studied included Hoopes' aluminum (99.98 percent pure), 2S-H14, 3S-H14 4S-H34, 14S-T4, 24S-T3, 52S-H34, 61S-T4, and 75S-T6. Buffer solutions were prepared from potassium hydrogen phthalate, various phosphates, sodium carbonate and bicarbonate, hydrochloric acid and sodium hydroxide. A background electrolyte of 0.1 M tetramethylammonium bromide or chloride was used to study the combined effect of free oxygen (air) and carbon dioxide, or hydrogen peroxide and carbon dioxide. Solutions of hydrogen ion were made from potassium chloride and hydrochloric acid.

A manual polarograph assembled from standard physical-chemical equipment was used except for occasional checking with a Sargent Polarograph Model XII.—PDA.

3. CHARACTERISTIC CORROSION PHENOMENA

3.6 Electrochemical Effects

3.6.6, 1.7.1

Report of (ASTM) Sub-Committee VIII on Galvanic and Electrolytic Corrosion. *Proc. Am. Soc. Testing Materials*, 48, 167-175 (1948).

A progress report presenting data obtained in a series of tests started in 1941 to determine the corrosion behavior of various other metals and alloys coupled with stainless steels and exposed to typical atmospheres. Final specimens will be removed in 1951. This report gives details of testing and cleaning procedures. No conclusions are drawn.

3.6.7, 4.5.2, 5.2.1, 7.7, 7.8

Electrolysis Control Handbook. (Denshoku Boshi Hand Book. In Japanese) 466 pages, 355 figures. Edited by Electrolysis Control Research Committee (Denshoku Boshi Kenkyu Iinkai). Published by the Institute of Electrical Engineers of Japan, Tokyo, April 5, 1952. Price per copy, plus postage . . . Yen 600.

A thoroughly revised and enlarged edition of Denshokyu Boshi Soten (Electrolysis Control Guide Book) published in 1937.

Included are statistics on corrosion damage to communication and power cables in Japan, theory of underground corrosion, analysis of stray current distribution from railways, rail bonding, railway current feeding systems, measurement of stray currents, cable sheath and pipe line currents.

Material on chemical analysis of earth, underground water and deposits on corroded metals methods of mitigating corrosion on lead sheaths and pipe lines, cathodic protection, inhibitors, protective coverings estimating corrosivity of underground water, and recommended specifications for cable sheaths (JEC-121A, JEC-121B, JEC-121C, April, 1951).

The book also gives current governmental regulations to protect underground structures from corrosion, examples of similar regulations in other

countries, such as Germany (VDE 1933), Switzerland, Britain (1920), France (1911), Spain (1900), recommendations by OCIF in Paris (1949).

Organization of the Electrolysis Control Research Committee in Japan, its members and activities also are included.

3.6.9, 3.6.2

Electrolytic Corrosion and the General Theory of Corrosion. *Indust. Finishing* (London), 3, No. 31, 475-476, 478, 480, 482 (1951).

A Summary of a report of the Electrolytic Corrosion Sub-Committee of the Institution of Gas Engineers. The causes of electrolytic corrosion are considered, and the following types are discussed: 1) stray current, 2) soil corrosion, 3) self corrosion, 4) chemical, 5) A: C corrosion, and 6) anaerobic corrosion. Some recommendations are made on the protection of underground pipes and cables.—MA.

3.7 Metallurgical Effects

3.7.3, 3.2.2, 6.2.4

Weldability of Chromium-Nickel Steels Resistant to Chemical Agents. F. RAPATZ, Berg- U. huttenmann. *Monatsh. montan. Hochschule Leoben*, 95, No. 12, 368-370 (1950).

Discussion of problem of hot short cracks or microfissures, in weldments of chemically resistant austenitic chromium-nickel steels. Effect of ferrite content. Metallurgical measures likely to insure freedom from hot short cracking in purely austenitic steels. Mechanism of effect of acid nonmetallic inclusions. Influence of increased manganese content; explanation; performance of austenitic steels containing up to 4 percent manganese, in welding. Effect of increased carbon content on hot short cracking. Occurrence of carbide-containing component in grain boundaries. Why are austenitic chromium-nickel steels more susceptible to hot short cracking than other steels? Role of manganese in connection with welding and forging in general.

Translation available Henry Bratcher, P. O. Box 157, Altadena, Calif.

3.7.3, 6.4.2

Soft Soldering of Electroplated Aluminum Alloy Components. E. E. HALLS. *Electroplating*, 3, No. 13, 493-494 (1950) Sept.

Aluminum alloy components electroplated with copper, tin, or silver can be successfully soft-soldered. Corrosion and corrosive deposits can be avoided by the use of a non-corrosive fluxing agent such as a pure resin-base flux or an activated resin flux containing not more than 5 percent chlorine in the form of a chloride-type activator. The electroplating can be protected by keeping the soldering temperature at or below 300° C. A solder containing 60-65 percent tin and the remainder lead produces a neat, sound joint. Zinc and aluminum must be absent from the solder and only 0.05-0.10 percent antimony can be present, as it restricts the flow of the solder.

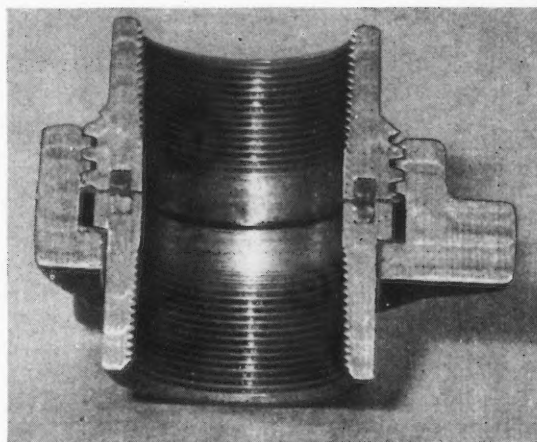
Numerous joints on the same component can be soldered in one operation with a solder paste containing the resin flux and the solder incorporated in the powder form, used in conjunction with oven or induction heating; the results are uniform and the cost is low. A good

A COMPLETE LINE OF HIGH PRESSURE INSULATED UNIONS FOR ELECTROLYSIS CONTROL

only from *BK*

Now—in one complete package, you get a completely insulated joint with working pressures to suit your individual needs.

- 1** Brance-Krachy insulated unions in all sizes . . . from 1/4" to 10".
- 2** Brance-Krachy insulated unions in working pressures from 1,000 lbs. to your individual needs.
- 3** Brance-Krachy insulated unions are assembled so that insulation is a permanent part of assembly. Insulation will not come out even though union is opened repeatedly.



**APPROVED BY SOUTHWESTERN
LABORATORIES**



Brance-Krachy Co. INC.

4411 NAVIGATION • P.O. Box 1724 • HOUSTON

FOR FULL INFORMATION, WRITE, WIRE OR TELETYPE (HO-561)

- 4411 Navigation Blvd., P. O. Box 1724, Houston.
- California—2850 E. Florence St., Huntington Park, Calif.
- Oklahoma—321 1/2 Johnson St., Bartlesville, Okla. Phone 5798.
- P. O. Box 66, Beaumont, Texas.

BRANCE-KRACHY CO., INC.
P. O. Box 1724, Houston, Texas

Please send me details on the complete line of high pressure insulated unions.

Name _____ Title _____

Company Address _____

City _____ State _____

paste, preferred to a proprietary composition, contains 100 g of a 200-mesh solder powder, 45 g resin, 1 g resin oil, and 12.5 ml butanol. The solder powder contains approximately 64 percent tin, 0.17 percent antimony, and the remainder lead. The resin base should be a vacuum-distilled colophony resin having an acid value of 170-175 mg potassium hydroxide per g resin. The articles to be soldered are permitted to remain approximately 20 minutes in a preheated oven maintained at 240-250° C. When the soldered articles are removed from the oven, the flux is removed with a trichloroethylene vapor degreaser. The metal is then protected against tarnishing by coating with a petroleum jelly applied from a 1-2 percent solution in petroleum ether.—PDA.

3.7.4, 6.2.2, 3.5.9, 5.9.4

Existence of a Nucleation Process in Controlled Oxidation of Iron at High Temperatures. (In French.) JEAN BARDETTE AND JACQUES BENARD. *Compt. Rend.*, **232**, 231-232 (1951) Jan. 15.

The above was studied using pure electrolytic or Armco iron at 850° C. under vacuum, using nitrogen plus traces of oxygen, oxides, or incompletely deoxidized metals as deoxidizing agents. Results prove existence of a relationship between orientation of the oxide lattice and that of the base metal.—BLR.

4. CORROSIVE ENVIRONMENTS

4.2 Atmospheric

4.2.1, 1.3

Theory of Atmospheric Corrosion of Metals. (In Russian.) N. D. TOMASHOV. *Uspekhi Khim.* (Progress of Chemistry) (USSR), **19**, 716-729 (1950) Nov.-Dec.

Reviews and discusses the literature on 3 types of atmospheric corrosion (moist, wet, and dry). The relation between oxygen and hydrogen depolarization, role of cathodic inclusions in alloys, protective properties of corrosion products, and means of developing protection against atmospheric corrosion are discussed. 12 references.—BLR.

4.6 Water and Steam

4.6.6, 5.8.2, 8.1.4

Sodium Tripolyphosphate in the Quality Improvement of Water. GERHARD AMMER. *Vom Wasser*, **17**, 128 (1949).

In contrast to o-phosphates, addition of cold dilute solutions of polyphosphates to hard waters does not cause precipitation, but causes stabilization of hardness compounds by inhibition of formation of crystal nuclei. Of polyphosphate series $\text{Na}_5\text{P}_3\text{O}_{10}$ is not yet generally acceptable in water industry although it has several favorable properties. It is not deliquescent nor hygroscopic and thus can be shipped and proportioned without difficulty. pH of 1 percent solution is between 8.6 and 9, i.e., corrosion effects on iron proportioning equipment are insignificant. Efficiency of compound studied by comparison with more generally used $\text{Na}_2\text{P}_2\text{O}_7$. Under exceptional conditions used, stabilizing effect of both polyphosphates are practically equal, although Bell reported more favorable results with

$\text{Na}_5\text{P}_3\text{O}_{10}$ under somewhat different conditions.—AWWA.

4.6.11, 8.4.3

Corrosion and Protection of Offshore Drilling Rigs. Summary of Discussion. F. L. LAQUE. N.A.C.E., 5th Ann. Conf., Cincinnati, Apr. 11-14, 1949. *Corrosion*, **6**, 161-166 (1950) May.

The following points were discussed during a panel on corrosion and protection of offshore drilling rigs:

1) Maximum corrosion of bare steel occurs in the splash zone just above the usual high tide level.

2) Minimum corrosion occurs in the tidal zone which receives local cell cathodic protection by current which flows from an anodic area just below low tide.

3) A secondary peak in corrosion rate occurs in the anodic region just below low tide.

4) Corrosion below the mud line ordinarily proceeds at rates lower than those in the water or the atmosphere above it.

5) It is easy to arrest corrosion below low tide by the application of cathodic protection.

6) It is relatively difficult, and perhaps uneconomical, to arrest corrosion in the tidal zone and especially in the most critical area just above high tide by the application of cathodic protection.

7) Steel in the tidal zone and just above it should be protected by a protective coating or a sheathing of corrosion resisting metal as a supplement to cathodic protection of the continuously immersed areas.

8) Experiments with Monel in the tidal zone connected to steel below low tide as compared to steel in both zones showed that a. Corrosion of steel below low tide in contact with Monel in the tidal zone was no faster than when in contact with steel in the tidal zone. b. It was easier rather than more difficult to cathodically protect steel below low tide when in contact with Monel instead of steel in the tidal zone. (Presumably this was due to the greater ease of polarizing Monel and would apply as well to any other corrosion resisting metal having favorable cathodic polarization characteristics.)

5. PREVENTIVE MEASURES

5.2 Cathodic Protection

5.2.3, 7.4.1

Radiant Heating Systems Need Cathodic Protection Too. J. F. HIRSHFELD AND L. P. SCHAEFER. The Hinchman Corp., Detroit, Mich. *Mass Transportation*, **48**, No. 1, 46-48 (1952) Jan.; *Corrosion*, **8**, No. 4, 140-142 (1952) Apr.

For approximately \$30,000 two cathodic protection systems were installed in two bus garages of the Detroit City Department of Street Railways avoiding replacement of a radiant heating system installed under garage floors with a less efficient space heater arrangement which would have cost \$80,000. The radiant heating system piping, installed in a sand fill beneath a concrete floor in soil of high corrosivity provided heat for about 500,000 square feet of floor space. Salt and water melted from buses stored in the garages, seeped through cracks in the concrete floor causing between 150 and 200 leaks under one building alone and the loss of about 3000 gallons of 140 degree water per month. The

cathodic protection system consisted of graphite anode rods installed under the concrete floor connected to selenium rectifiers of appropriate capacity. Accurate check of potentials is being kept.

5.2.3, 7.5.5, 2.2.4

A Field Investigation of Cathodic Protection in Glass Lined and Galvanized Water Heaters. W. A. DERINGER AND F. W. NELSON. Paper, Seventh Annual Conference Natl. Assoc. Corrosion Engrs., New York, N. Y., March 13-16, 1951. *Corrosion*, **8**, No. 2, 57-64 (1952) Feb.

Research started by A. O. Smith Corporation more than twenty years ago demonstrated that the effectiveness of cathodic protection was greatly enhanced when coupled with a glass-fused-to-steel coating. This work resulted in the patent No. 2267361. Subsequent research and field experience with glass-lined domestic water heaters indicated this principle could, perhaps, be applied to advantage in this product. The glass-lining, being an inert, non-conductive coating, would impose no current drain on the cathodic protection device used.

Heretofore the glass-lining was the sole protector of water heater tanks against corrosion, and (as in any manufactured product) there was always the possibility the coating might not be perfect. It was thought a magnesium anode might serve as a pinch hitter to protect steel areas exposed if the glass coverage was imperfect.

To evaluate cathodic protection in glass-lined water heaters a rather elaborate field test program was begun, involving installation of four glass-lined and two galvanized water heaters in each of twelve very carefully selected cities in the Eastern half of the United States. Construction of tanks used and the method of installing the magnesium anode is shown. Coatings on all tanks were damaged deliberately to make possible evaluation of the effectiveness of cathodic protection under abnormally adverse conditions. Plans included determination of current flow, anode life, effect of cathodic protection on the coating itself and the possibility of incorporating several cost saving features in glass-lined water heaters when magnesium anodes were used. After installation, these heaters were inspected at regular intervals both visually and electrically. After one year, half the heaters were removed and dissected.

Results of this field test program showed how magnesium anodes behave both in galvanized and glass-lined water heaters under a variety of water and performance conditions. Anode life under these conditions was determined and anode life expectancy graphs are shown. Photographs of many of the bi-sectioned water heaters are also shown.

5.2.3, 7.5.5, 4.6.1

Field Test of a Cathodic-Protection Installation. H. A. SWEET. *J. Am. Water Works Assoc.*, **42**, No. 6, 551-552 (1950).

Sweet describes a field test to determine whether or not the cathodic-protection equipment installed in a 75,000-gallon water tank furnished adequate protection against corrosion. Protected and unprotected mild-steel specimens were inserted in the tank for approximately 4 months and the loss in weight due to corrosion was estimated. It was concluded that the cathodic protection furnished by the equipment was definitely of value in reducing the rapidity

THERE IS NO SUBSTITUTE FOR EXPERIENCE



"PUTTING
Permanence
IN PIPE"

CLEANING, COATING, WRAPPING & RECONDITIONING

Are you being fair to yourself and your company when you buy pipe protection on price without questioning what you're getting for *that* price? Our price quotations give you unquestionable work backed by more than 25 years' experience, modern equipment and plant manned by skilled craftsmen, a 56-acre pipe yard on which more than 300 million feet of pipe (½" to 60") has been coated and wrapped to the entire satisfaction of the customers. This record is hard to match.

MAYES BROS.

1150
McCarty

HOUSTON, TEXAS

ORchard
7566

of corrosion of the specimens tested in the tank for the 4-month period. It was also found that an unprotected specimen near the top of the tank corroded approximately 7 times as rapidly as the protected specimen in the same position. The unprotected specimen near the base of the tank, however, corroded only 4 times as rapidly as the protected specimen.—MA.

5.3 Metallic Coatings

5.3.1, 5.4.1

Metallic and Non-Metallic Coatings for Gray Iron. C. O. BURGESS. Brochure (Preprint of Chapter VIII of the Gray Iron Handbook), 1950, 76 pp. Gray Iron Founders' Society, Inc., Cleveland, Ohio. \$1.75.

Covers sprayed metals, hot-dipping, hard facing, cementation, electrodeposition, paints, vitreous enamels, chemical coatings (oxide, phosphate and nitride), coloring and cement linings. Coating metals include tin, zinc, lead, lead-tin, aluminum, chromium, nickel, cadmium, copper. 175 references.

5.3.2, 5.3.4, 2.3.6

On the Structure and Properties of Some Metal and Metal Oxide Films. GEORG HAAS AND NOEL W. SCOTT. U. S. Engineer Center, Fort Belvoir, Va. *J. Phys. Radium*, 11, 394-402 (1950) July.

Electron microscope and electron diffraction studies were made of the optical, electrical, and chemical properties of thin films formed by the vacuum evaporation of aluminum, silver, germanium, silicon, and silicon dioxide plus silicon.

Aluminum is a more desirable reflecting material for front-surface mirrors than silver, despite the higher reflectivity of silver. Aluminum films are smoother, more uniform, finer grained, and less easily tarnished.

The thickness of the natural oxide films on aluminum can be increased by heat treatment in air or by anodic oxidation. The heat treatment method is not practical because of the high temperature required and the resultant rough and nonuniform films obtained. Satisfactory anodically formed oxide films of precise thicknesses can be prepared in 3 percent ammonium tartrate electrolyte of pH 5 by regulating the anodizing voltage. The films are non-porous, amorphous, and are resistant to scratching and abrasion. Oxide films of 1560 Å thickness, formed at 120 v, provide the highest reflectivity in the visible. No appreciable absorption occurs in the ultraviolet or infrared.

When condensed by high-vacuum evaporation, germanium and silicon form crystalline films on heated bases only.

High vacuum evaporation of silicon is difficult because of the high temperatures necessary for evaporation. Hard, adherent, amorphous silicon dioxide films having good mechanical and chemical properties can be produced by evaporating silicon onto an aluminum surface and then oxidizing to silicon dioxide by anodizing in an ammonium tartrate bath.

Whereas vacuum evaporation of silicon is difficult, silicon monoxide evaporates easily and produces satisfactory protective films. The best results are obtained by evaporating silicon monoxide from a mixture of silicon dioxide

plus silicon in a tube evacuated to about 1×10^{-4} mm mercury.

Silicon monoxide is useful for producing protected front-surface mirrors on metals and plastics, as well as on glass bases. For coating metal, a silicon monoxide film about 2000 Å thick is evaporated onto the metal form, followed by a coating of aluminum, and, finally, the protective silicon monoxide film. The first silicon monoxide film improves the adhesion of the films. Plastics are coated in a similar manner.—PDA.

5.3.4, 5.3.2

The Corrosion-Resistance of Nickel and Chromium Electrodeposits. I-II. J. LIGER. *Galvano*, 19, No. 166, 15-19; No. 167, 11-14 (1950).

I.—A review of published work on the protective values of nickel and/or chromium electrodeposits applied to steel surfaces, as determined by accelerated or outdoor corrosion tests. The factors considered include the effects of coating thickness, the value of copper, zinc, or cadmium plating prior to nickel deposition and the influence of the composition of the atmosphere on corrosion resistance.

II.—Porosity, cracks, and poor adherence reduce the protective value of nickel coatings. The causes and methods for overcoming such defects are reviewed.—MA.

5.3.4, 5.3.2, 3.8.2

Corrosion of Composite Electroplated Coatings. ALLEN G. GRAY. *Products Finishing*, 15, No. 1, 44- (1950) Oct.

On the basis of results obtained from salt spray and outdoor exposure tests two rules are presented for the prevention of corrosion of single as well as of composite electrodeposited coatings. These rules are in addition to the recognized method of minimizing corrosion by increasing the thickness of the coating.

1) In the galvanic series of metals, any metal applied to another metal lower in the series will inhibit corrosion of the basis metal. The applied metal may provide cathodic protection if it is more anodic than the potential required of the basis metal to prevent its corrosion in that same environment. Conversely, any metal applied to another metal higher in the series will tend to promote pinpoint corrosion whenever the potential of the applied metal is more cathodic than the potential at which anodic corrosion of the basis metal occurs.

2) When two or more composite metal coatings are applied to a basis metal, greatest corrosion inhibition of the basis metal is obtained when the most noble of the applied metal coatings is directly beneath the outer surface metal. Cathodic protection is possible if the difference in potential between the most noble and the least noble metal of the applied coatings under the conditions of test is greater than the potential required of the basis metal to prevent its corrosion. Corrosion of the basis metal is encouraged when the most noble metal of the composite coating is applied on the outside surface.

A silver strike a few hundredths of a mil thick on a coating of copper, followed by nickel and chromium, offered better protection against corrosion than the same total thickness of nickel under chromium or of copper plus nickel under chromium without the silver strike. On another test a strike of tin under the

copper added materially to the corrosion resistance, and a combination of coatings consisting of 0.015 mil tin, 0.2 mil copper, 0.05 mil silver, 0.25 mil nickel, and 0.01 mil chromium withstood corrosion twice as well as double the thickness of nickel alone under chromium. Copper under zinc or cadmium offered more protection to steel than did a similar thickness of zinc or cadmium alone.

5.3.4, 5.3.3

A Survey of Coating-Thickness Variation on Commercially Galvanized Sheets. M. L. HUGHES. *J. Iron Steel Inst.*, 167, No. 1, 48-65 (1951) Jan.

In view of the close relationship between the thickness and the protective value of zinc coatings, an examination of the distribution of coating thickness on representative samples of commercially galvanized steel sheets was made. The results of measurements along, across, and upon either side of the sheets are reported, and the probable relationship between the different types of thickness variation observed and existing techniques of galvanizing is discussed.—BNF.

5.3.4, 6.2.2

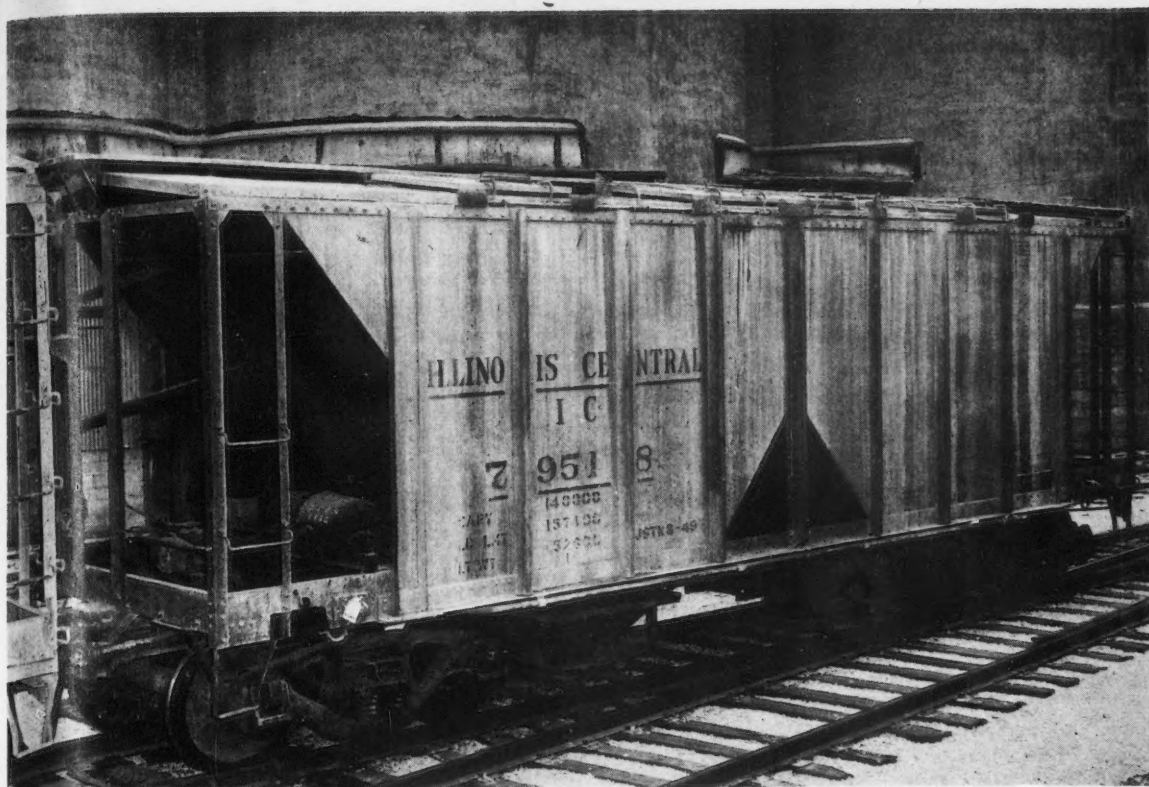
Hot-Dip Galvanizing of Powder Iron Compacts. H. BABLIK, F. GOTZL, AND R. KUKACZKA. *Sheet Metal Inds.*, 28, No. 287, 267-281 (1951) Mar.

Hot-dip galvanizing of powder iron can be carried out. In relation to corrosion, hot-dip galvanized powder iron is to be considered equal to hot-dip galvanized rolled-iron. It is necessary to carry out the process of hot-dip galvanizing so that only very short pickling is used and the galvanizing proper carried through according to the dry-galvanizing process in order not to carry superfluous water which would tend to oxidize the zinc in the zinc bath. An addition of aluminum within the usual limits is ineffective with powder iron. The tensile strength is slightly reduced by hot-dip galvanizing. For powder iron, hot-dip galvanizing provides the same effective protection to corrosion as for rolled iron.—INCO.

5.3.4, 6.3.9, 6.3.10, 6.2.5

Final Report on Cladding of Molybdenum to the Rand Corporation. W. L. BRUCKART, S. J. WHALEN, R. I. JAFFEE, AND B. W. GONSER. *Battelle Memorial Inst. Apr. 25, 1950.* 102 p. (NP-1861).

This report covers an evaluation of the processing and properties of three kinds of commercially available molybdenum clad with a variety of potentially useful cladding materials. In all cases, the composites produced were of the double-clad type, usually with cladding thicknesses of 15 percent per side, although some work was done with thinner clads. The molybdenum core materials were of three types: electric-bell sintered (Fansteel), wet-hydrogen sintered (Westinghouse), and arc cast (Climax). The cladding materials were chosen for their oxidation resistance at elevated temperature. They were nickel, Inconel, 18-8 stainless steel, 25-20 stainless steel, 27-chromium-ferritic steel, Hastelloy B, Stellite 21, and platinum 10Rh alloy. Cladding on molybdenum was done successfully with platinum 10Rh, nickel, Inconel, and 18-8 stainless steel (Type 302) with bond strengths decreasing in the order given. On the basis of qualitative tests, the bonding of molybdenum to the platinum alloy appeared to be best. Various rolling temperatures were also investigated. In general, the use of lower finishing tem-



No stops for painting in **SIX YEARS!**

Six years—that's the age of this car's finish—and it's still good! During this time it has been under attack from rain, heat, cold, sunlight, corrosive fumes, vibration, and pounding with sledge hammers to hasten unloading . . . and the coating is still on the job!



In six years, a lot of sledge-hammer blows dented this car's sides . . . notice how the VINYLITE Resin coatings stuck fast and prevented rust creepage!

It's another example of the service and dependability you'll get from coatings based on VINYLITE Brand Resins. Properly formulated and applied, these coatings resist oil, grease, chemicals, brine, alkalis and most strong acids. They're non-flammable, quick drying, odorless, tasteless, and non-toxic . . . protect containers from their contents and contents from containers. Applied by dip, brush, or spray, they stick fast to metal, concrete, or masonry. They have a wide range of colors—glossy, flat, or semi-glossy—that are unchanged by repeated scrubbing or washing.

Wherever corrosion and wear are

a problem—on tanks, pipelines, machinery, containers, rigging—use coatings based on VINYLITE Brand Resins. They have the unique properties that make VINYLITE Resins and Plastics so useful for scores of products in defense and basic industry. Write Dept. MZ-69.

Data on "Carclad" Three-Coat System courtesy Sherwin-Williams Company, 101 Prospect Ave., N.W., Cleveland 1, Ohio.

Vinylite

BRAND

RESINS



BAKELITE COMPANY

A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

peratures resulted in higher strength. Creep tests at 1800° F. were conducted on 15 percent double-clad nickel and 15 percent double-clad Inconel, both on cores of Westinghouse and Climax molybdenum. The lowest creep rates were found with nickel-clad Westinghouse molybdenum. Oxidation tests of unstressed, clad molybdenum at 1800°, 2000°, 2200° F. showed Inconel to be the superior of the two claddings insofar as metal loss by scaling is concerned. Studies of welding methods for joining and edge protecting clad molybdenum were made. Joints, brazed with an argon-shielded tungsten arc using Hastelloy B filler metal, showed tensile strengths of 50,000 to 64,000 psi. Of the several methods and filler metals studied, argon-arc brazing using Hastelloy B, was the best.—NSA.

5.3.4, 6.4.2

The Corrosion Resistance of Duralumin Finished in Different Ways. L. J. G. VAN EWIJK. N. V. Industrie, Vaassen, Neth. *Metaux & Corrosion*, 24, 261-273 (1949).

The results of corrosion experiments on Duralumin with and without various plated and/or anodized coatings are listed below:

1) Bare Duralumin showed low resistance to attack by aqueous sodium chloride solutions of pH 6-8. An anodized coating 15 μ thick increased the resistance, but not sufficiently to resist the severe corrosive environments encountered in aeronautics.

2) The resistance of bare Duralumin to atmospheric exposure was unexpectedly high, as shown by relatively low losses in mechanical properties after 6 years of atmospheric attack. Anodizing improved this resistance to the extent that practically no changes occurred in breaking strength and elasticity and losses in elongation occurred only at points where the anodic layer was too thin, i.e., about 8 μ .

3) Duralumin plated with pure aluminum or with an aluminum-magnesium-manganese alloy had excellent resistance to both immersion and atmospheric attack.

4) Little difference existed among platings of 99.5 percent aluminum, 99.99 percent aluminum, and magnesium-aluminum-manganese alloy. The last two platings seemed slightly superior to the first, but the difference in quality may have been caused by slight differences in thermal treatment, e.g., by diffusion of copper.

These experiments were conducted on different size specimens exposed 1 year to distilled water, or 2 months to running tap water, both containing 3 percent sodium chloride and 0.1 percent hydrogen peroxide, or 6 years to roof exposure on a building facing south at a 45° angle. The Aluminite process was used for anodizing.—PDA.

5.3.4, 6.4.2

Electroplating Aluminium and Aluminium Alloy Components. Part I—Study of Pretreatments and Dipping Processes. Part II—Electrolytes for Various Processes. E. E. HALLS. *Metal Treatment and Drop Forging* (England), 18, No. 66, 125-131, 177-182 (1951) Mar-Apr.

Part I—Electroplate coatings on aluminum and its alloys may be desirable or essential for one or more of the following reasons: 1) The finish may be desirable or essential as a sales feature;

2) it may be necessary as a permanent bright metallic coating for appearance reasons; 3) it may be needed to give protection against specific corroding conditions; 4) finish may be a practical method of minimizing electrochemical contact potential differences in assemblies in which various compositions of metal and alloy are unavoidable; 5) it may be an economic and convenient basis for soft soldering; 6) finish may be essential for high-frequency conductance; and 7) it may be required to promote properties of good wear resistance. The serviceability of the electroplated film is in some measure dependent upon the coating thickness, particularly adhesion and resistance to flaking. The sequence of plating operations is outlined, surface cleaning and degreasing being the first step. Next follows the critical preparatory treatment to ensure metal-to-metal contact and molecular adhesion. This involves treatments dealing with the oxide film and deals with the following: a) Processes involving immersion treatment in a strongly acidified heavy-metal salt solution; b) anodic oxidation followed by removal, or partial removal of the oxide film; c) immersion treatment in alkaline sodium-zincate solution; d) as in c), but with copper additions included; e) as in c), except after controlled oxidation.

Part II—Describes various electrolytes for electrodeposition of some common and rare metals on aluminum and its alloys. An appendix presents notes supported by test results on durability of such coatings.

5.4 Non-Metallic Coatings and Paints

5.4.5

Synthetic Resin Finishes. *Ind. Finishing* (London), 3, No. 31, 508-510 (1951).

An assessment of the relative values of 100 percent phenolic, modified phenolic, alkyd and modified alkyd finishes is given, together with reference to bitumens, silicones and rubber derivatives. For maximum durability, acid- and alkali-resistance and toughness, 100 percent phenolics are recommended, but they suffer from discoloration in sunlight and hence cannot be used in white enamels, etc. Oil-modified alkyd resins are second only to the phenolics and have good flexibility and color retention. Bitumens are black and opaque and are rarely pigmented. Small quantities of oil improve their toughness and resistance to wear. Silicone resins gave exceptional resistance to extremes of temperature and to chemical attack.—RPI.

5.4.5

A Study of Spalling Found in Porcelain Enamel After Repeated Freezing and Thawing in the Presence of Moisture. R. J. McEVoy AND A. I. ANDREWS. *J. Am. Ceramic Soc.*, 34, 135-141 (1951) May.

Above study was made in connection with defects found on porcelain-enamel liners in cold-wall domestic refrigerators. A test machine was built to duplicate the environment. It was found that enamels with a low bubble structure were superior in spall resistance. Ti enamel appeared better than other types, particularly when a clay of the Kaolin type was used as suspending agent. Equipment is illustrated; data are tabu-

lated; photomicrographs show enamel structures.—BLR.

5.4.5, 4.3.1, 4.4.1

Chemical Resistance of Phenolic and Alcohol Type Coatings. RAYMOND B. SEYMOUR AND ROBERT H. STEINER. Paper, Seventh Annual Conference, Natl. Assoc. Corrosion Engrs., New York, N. Y., March 13-16, 1951. *Corrosion*, 8, No. 2, 57-64 (1952) Feb.

Spot tests on panels, quantitative resistance tests on unsupported films and long term tests on immersed coated plummets were run in order to determine the corrosion and solvent resistance of acid-catalyzed phenolic coatings, baked phenolic coatings, baked modified phenolic coatings, and acid-catalyzed polyfurfuryl alcohol coatings. In general, all coatings tested had excellent resistance to solvents, non-oxidizing acids and salts over a wide range of temperature. The phenolic coatings had superior resistance to oxidizing acids and the baked modified phenolic coatings were superior to the baked and acid-catalyzed phenolic coatings. However, all phenolic coatings were attacked by high concentrations of oxidizing acids and by more dilute solutions at elevated temperatures. All tests on acid-catalyzed polyfurfuryl alcohol coatings showed these coatings to be completely resistant to alkalis in all concentrations over a wide range of temperature. Tests on coated plummets indicated that practical tests gave good correlation with both qualitative and quantitative screening tests on panels and unsupported films.

5.4.5, 4.3.2, 4.3.3.

Tar-Base Coating Is Anti-Corrosive. *Iron Steel Engr.*, 28, No. 11, 158 (1951) Feb.

Steelsaver, a high-gloss, coal tar protective coating is one of the coal tar base, anti-corrosive coatings formulated to protect metals, wood, masonry and insulations. Steelsaver is presently protecting air ducts, coke ovens, condenser coils, cranes, gas holders, rolling stock, steel work, tank exteriors, and valves. No primer is needed. The coating may be dipped, sprayed or brushed. Steelsaver protects in direct ratio to film thickness and number of coats applied. It resists strong inorganic acids and strong alkali, ranging from sulfuric acid to caustic potash. It also protects against, alcohol, formaldehyde, salt spray, a wide variety of organic acids and other chemicals. Manufactured by Continental Coatings Corp.—INCO.

5.4.5, 5.3.2

Cold Galvanizing. H. BARRON. *Ind. Fin. (Brit.)*, 3, 543-544, 546, 548-550+ (1951).

Cold galvanizing consists in coating the base metal (usually iron or steel) with polystyrene, isomerized rubber, or chlorinated rubber very highly pigmented with zinc powder. The coating, which is air-drying, gives an electrically conducting film containing about 95 percent zinc, and protects sacrificially for as long as metallic zinc remains near the corrosion sites. The results of various tests on the coating (e.g., temperature and humidity cycles, sea water, spray, etc.) are given.—RPI.

5.4.5, 5.4.7

Textured Organic Coatings. L. BECK. *Sherwin-Williams Co. Product Eng.*, 24, No. 4, 129-136 (1951) Apr.

New 1- and 2-coat spray application "special effect" finishes are rapidly sup-



News about COATINGS for METALS

Metallic Organic Decorative Protective

Using an Engineering Approach in Plant Painting

Cuts Maintenance Costs — Corrosion, too

Porosity no problem with Plastisol protection

In a recent test of many coatings for use in refrigeration equipment, only a Unichrome Plastisol Coating withstood 1500 hours of water immersion. All other coatings tested by the user failed because of porosity.

This case emphasizes why Unichrome Plastisols, which build up a film thickness of from 3 mils to 3/16-inch as desired, give such extraordinary protection to ordinary metals in contact with a wide variety of corrosives. The chemicals don't penetrate this heavy duty coating to attack the metal. Nor do they attack the coating itself since it is a vinyl formulation.

If you need an exceptional protective material for processing equipment, investigate a Unichrome Plastisol Compound.

Improved phenolic-type lining for drums

Phenolic coatings are the dependable "workhorse" of the drum lining industry. They have long been favored by packaging engineers for use in steel containers to protect the package from corrosion and the contents from contamination.

Unichrome Series B-124 Linings have been acknowledged by many users to be outstanding improvements in this type of material. They bake into extremely tough and durable linings that have excellent adhesion and unusual ability to withstand strong acids, oils, food chemicals, vinegar, wetting agents. Solvents such as benzene and ketones also have no effect on B-124 linings.

Other linings also available for other products. Write for data, and for information on manufacturers and reconditioners supplying drums with Unichrome Drum Linings.

Coatings have definitely become important materials of construction to the chemical or corrosion engineer. With many types of coating materials available to meet unusual requirements, no longer is surface protection being classed as merely another paint job. Instead, many plants are thinking of maintenance painting as an engineering problem, to be solved by an engineering approach.

Such an approach can make a big difference in results — both in longer lasting equipment and more durable paint jobs.

AN ENGINEERED PAINTING PROGRAM

Engineering a solution to a painting problem means devoting proper attention to surface preparation for the coatings which are to be applied. It means specifying a system or combination of coatings devised for the service conditions encountered.

ADEQUATE SURFACE PREPARATION

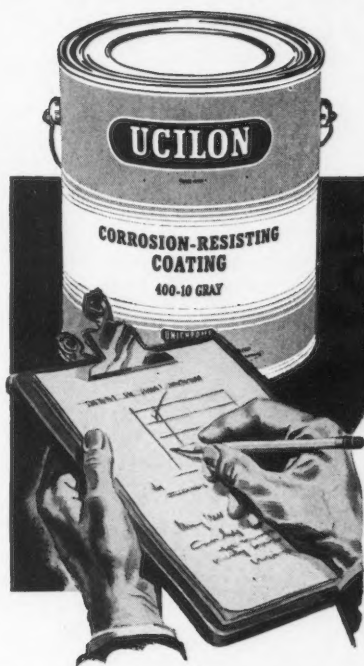
Generally, the tougher the corrosion problem, the more attention the surface needs. Sometimes this includes careful mechanical preparation. Experience has shown that, when required, one of the most important steps is also priming. This contributes to better adhesion of subsequent top coats. It adds extra corrosion resistance and minimizes undercutting of the protective film in the event of a break in its continuity.

Ucilon Coating Systems include proved materials for use in priming wherever individual applications require them. These include chromate-type primers, wash primers, intercoats.

CORROSION PROBLEMS SOLVED

Systems of Ucilon Coatings form effective barriers to a hundred and one tough, corrosive conditions. Many such systems are available to permit the engineer to specify a material that protects against intermittent or continuous contact with acids, alkalies, salt solutions, alcohols, moisture, oils, chemical compounds and other products.

Protection provided by Ucilon Coatings is based on vinyl, chlorinated rub-



ber, phenolic or fish oil formulations and the degrees of chemical resistance that such materials possess. Some coatings require baking. Most dry by solvent evaporation or by oxidation.

"AN OUNCE OF PREVENTION"

Preventive maintenance was always a good idea. Today it can be considered virtually vital in order to end needless corrosion of equipment and avoid the production delays, costly downtime and replacement headaches that such damage entails. Ucilon Coatings Systems can help you achieve longer lasting protection at lower cost and make your preventive maintenance more effective.

Be sure to look up the concise facts on Ucilon Coatings in your latest "C.E.C." Or write for bulletin No. MC-6.

UNITED CHROMIUM, INCORPORATED

100 East 42nd Street, New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.

In Canada:

United Chromium Limited, Toronto, Ont.

planting older types. Application characteristics, appearance and film properties compare favorably with the usual protective enamels. The organic coatings discussed include polychrome metallic, hammer finishes, wrinkle, spatter, lacquer and black finishes. Chart classifying organic coatings to be applied on metal products is added.—INCO.

5.4.5, 5.8.2

Phosphor Etch Primer. *Light Metals* (England) 14, No. 157, 182 (1951) Apr.

Foochow phosphor etch primer, produced by Donald McPherson and Co., Ltd., combines a pretreatment etch or pickle with the deposition of a special chromate corrosion inhibiting film chemically painted to the metal surface and at the same time forming a foundation for subsequent finishing coats. It is applicable by spray or brush to aluminum and its alloys, iron, steel, zinc, galvanized iron, tinplate, copper, brass, cadmium plate and many plastic materials such as Bakelite and Perplex.—ALL.

5.4.5, 6.3.19, 5.9.2

Paint Applications to Zinc Surfaces. *Ind. Finishing* (U. K.), 3, No. 32, 574-581 (1951) Feb.

An article describing the Cronak process for increasing the corrosion resistance of zinc and zinc alloy surfaces, and its use as a base for subsequent paint finishes. Stoved finishes are said to be recommended because of their better adhesion to the chromate film, and a table lists maximum baking temperatures for different types of zinc surfaces. Alkaline and solvent cleaning processes, and chemical and mechanical pretreatments are also mentioned.—ZDA.

5.4.5, 6.4.2, 6.3.19

Chemically-Inert Synthetic Enamel Required for Microscopes. C. HENDERSON. *Die Castings* (U. S. A.), 9, No. 3, 27+ (1951) Mar.

The finishing of die cast aluminum and zinc parts in the new line of Bausch and Lomb stereoscopic wide field microscopes is critical because the finish is not only decorative, but must be chemically inert and easy to keep clean. A semi-gloss synthetic enamel in a soft grey color was chosen to provide the necessary protection. The aluminum die castings, except those with bronze inserts, are anodized in a sulphuric-acid type bath, and dyed black. This finish provides an excellent paint base for exterior surfaces and a non-reflective optical black for interior surfaces. Aluminum die castings with bronze inserts are phosphated prior to painting. Grinding and polishing is carefully done with three types of polishing equipment to provide a maximum surface smoothness. Dust is carefully controlled in the organic finishing department where the instruments receive a primer coat formulated to bake at 300° F. (148° C.) for one hour. The prime coat is then scuffed with 400 grit paper and the final coat of enamel is sprayed and baked.—ALL.

5.4.5, 6.4.2, 6.4.4

The Painting, Enamelling, and Lacquering of Light Metals. Parts I.—II. *Light Metals*, 13, No. 144, 32-37; No. 145, 84-92 (1950).

I.—In this survey of painting procedures for light alloys, the author firstly notes the difference between these materials and the heavy non-ferrous metals and steels with respect to suitable painted coatings and the necessary

cleaning procedures. It is pointed out that the performance of the paint depends upon the underlying alloy. Cleaning treatments are discussed, and the preparation of castings receives particular attention. Mechanical methods of pretreating aluminum alloys for painting are discussed.

II.—Chemical methods of pretreatment for painting are described, including the phosphoric acid, chromic-sulphuric acid, and chemical oxidation processes. The various types of priming and finishing paint which may be used are discussed. The pretreatment and painting of magnesium alloys is considered separately. The acid and caustic anodizing treatments are briefly described.—MA.

5.4.5, 8.9.1

New Finish System Promises High Erosion Resistance. GILBERT C. CLOSE. *Products Finishing*, 15, 30-32 (1951) Feb.

Describes 2-coat system incorporating synthetic resins and rubber developed by Minnesota Mining and Mfg. Co. for aerodynamic leading edges of high-speed military airplanes. Tests with this coating indicate it will serve as well for other uses where high erosion or abrasion resistance is required.—BLR.

5.4.7

A Study of the Electrostatic Spray-Coating Process. Part I. (In Japanese.) SUSUMU YOSHIDA, SHIGETAKE OKAMOTO AND KIYOSHI TAMURA. *J. Mechanical Laboratory*, 4, No. 6, 224-231 (1950) Oct.

Experimental work was done to determine fundamental conditions for carrying out the above process and to investigate its mechanism. Samples were rectangular metallic plates, pipes, and various parts of bicycle bodies. It was found that by employing suitable conditions, efficiency of spraying could be raised to as high as 50-60 percent with an electrostatic field, as compared to 20-30 percent without field. Influences of electrostatic field on hardness, adhesion, and gloss of paint films were also studied. Size distribution of paint particles which had passed through an electric field was determined by means of a string electrometer. Data are tabulated and charted. 10 references.—BLR.

5.4.8, 2.1.2, 2.3.3

Antifouling Paints; Inherent Errors in Determination of Leaching Rate. ALLEN L. ALEXANDER, J. B. BALLENTINE, AND M. O. YEITER. *Ind. and Eng. Chem.*, 43, 931-935 (1951) Apr.

Limitations associated with the standard leaching-rate determination and effects of variables on validity of conclusions based on leaching-rate values were studied. Data based on a large number of determinations describe an average-mean deviation that may be expected in leaching-rate values determined at intervals over a 5-month period. Because earlier research has established a minimum toxic solution rate for efficient copper-bearing paints, leaching-rate values may now be used as a more reliable measure of this function in the formulation of successful antifouling paints.—BLR.

5.4.8, 3.3.2

Underwater Paints. C. Salvi. *Ind. del Vernice*, 4, No. 44, 222-231 (1950).

Anti-corrosive and anti-fouling paints are reviewed. In a comparative test of a series of anti-corrosive paints by an electrochemical method it was found

that: alkyl paints pigmented with basic or neutral lead chromate or zinc chromate were less resistant than oil paints with red lead or red lead/basic lead chromate; under acid conditions the best results were given by the red lead oil paint, but under neutral conditions by the red lead/basic chromate oil paint; all the chromate paints performed poorly under acid conditions. For anti-fouling paints the advantages of using an oleoresinous medium based on oil modified by reaction with arsenic trichloride and mercury-resinate are pointed out.—RPI.

5.4.8, 3.3.2, 8.9.5

Process of Attachment to Ships' Bottoms and the Mechanism of Poisoning by Anti-Fouling Compositions. M. RAGE. *Farbe u. Lack*, 56, No. 12, 530-537 (1950).

The growth of marine organisms depends on the sulfur, phosphorus, nitrogen, silicon, nitrate and phosphate contents and the temperature of the sea water. The occurrence of fouling organisms in plankton is variable according to season and latitude. The main types of fouling are described and illustrated. Bacterial organisms probably adhere to surfaces by adsorption, but more complex types are attached by gelatinous materials containing albumin or pectin. Some copper and mercury compounds can precipitate albumin, etc., but the concentrations known to be effective in anti-fouling compositions are hardly sufficient to effect this precipitation, except in a non-turbulent layer of water within 0.02 mm. of the surface of the anti-fouling compound. The theory, that the concentration of copper and mercury ions adjacent to the anti-fouling surface is increased by the acidic secretions of the organisms, is discussed, and it is shown that many organisms can absorb relatively large quantities of copper and mercury without injury. Other chemical and physical processes to explain the mechanism of poisoning are considered.—RPI.

8. INDUSTRIES

8.1 Group 1

8.1.2, 5.4.1, 5.3.1

Protection of Structural Steelwork Against Corrosion. G. T. COLEGATE. *Iron and Coal Trades Rev.*, 161, No. 4316, 1035-1041 (1950) Dec. 29; 162, Nos. 4317-4319, 37-43, 87-93 and 141-150 (1951) Jan. 5, 12 and 19.

The first two instalments of the article contain detailed descriptions of the various ways of preparing steelwork for protective finishes. In the third the author gives advice on the circumstances for which each preparatory treatment is best suited and then goes on to discuss the choice of priming and finishing paints. The last instalment deals with metallic coatings, including zinc applied by spraying and hot dip galvanizing, and with the factors governing the choice of a protective system for steelwork.—ZDA.

8.1.2, 6.4.2

Progress Report, Duralumin H Shuttering. *Light Metals* (England), 14, No. 155, 92-93 (1951) Feb.

Light-alloy shuttering was used by George Wimpey and Co. Ltd. when constructing houses in Sumatra by the "Situfam" process. The shuttering was subjected continuously to a saline at-

h basic
c chro-
pains
ic lead
he best
ead oil
ons by
aint; all
poorly
fouling
n oleo-
modified
de and
—RPL

s' Bot-
soning
RAGG.
(1950).
ms de-
nitro-
ne con-
he sea
organ-
ording
types
trated.
ere to
com-
tinuous
pectin.
ounds
at the
itive in
sully sul-
except
within
i-foul-
e con-
y ions
ace is
of the
shown
rela-
r and
emical
n the
dered.

work
Iron
4316.
Nos.
41-150

arti-
of the
rk for
the
ances
ent is
discuss
shing
with
plied
izing,
the
steel

Shut-
No

d by
con-
the
was
e at

mosphere and contact with concrete. Original shuttering has been successfully used for a year, some of it nearly 100 times. Two other contracts have been operating since December 1949, using an improved development of the original shutter. The shuttering was originally designed to withstand liquid pressures up to 10 ft. hydrostatic head, but walls have been successfully poured up to 12 ft. 6 ins. head in practice. The same type of shuttering has also been used by the company to support normal dense concrete floors. Where a skin plaster ceiling finish is to be provided, sand is sprinkled on the shuttering so that a sufficiently roughened surface is left to form a key for the subsequent plastering coat. A large number of similar reinforced concrete staircases were constructed with specially designed light-alloy shutters. The use of steel nuts and bolts, etc., in contact with the light-alloy units does not seem to have any serious deleterious effect provided that the steel is greased.—ALL.

8.1.4

How to Dispose of Acid Wastes. J. E. COOPER. *Chem. Inds.*, 66, 684 (1950) May.

Acid wastes of pH below 4.5 corrode sewer lines, interfere with sewage treatment, kill fish. Cheapest treatment is dilution, if there is enough dilution water of sufficient alkalinity and it does not contain other pollutants like iron, copper, chromium. Sometimes waste and diluting water must be mixed artificially to prevent local acid concentrations. Neutralization of acid wastes is generally done with limestone beds. Upflow beds use 10-16-mesh stones, downflow 1-3 inch stones. High-calcium limestone acts more rapidly than dolomitic. Upflow beds, 18-24 inches deep, are operated at 40 gpm. per sq. ft.; downflow beds, 5 feet deep, at 0.5-1 gpm. per sq. ft. Water should be low in turbidity, free from fat and grease and have less than 0.5 percent sulfuric acid. Effluent has pH around 4.2 due to free carbon dioxide; aeration can raise pH to 6 and higher.—AWWA.

8.1.4

The Effect of Zinc in Preventing Incrustation. (Le rôle du zinc dans l'inhibition de l'entartrage.) E. URION AND G. LEJEUNE. *Eau (France)*, 37, No. 2, 23-28 (1950).

Unscientific claims made for devices supplied for scale prevention in hot water systems led to this investigation, as a result of which the authors claim that the zinc coating on the fixing wires was responsible for the observed advantages. It is concluded from tests on natural and synthetic waters containing calcium that small quantities of zinc ion can prevent normal scale formation, the effect depending on the concentration of zinc in the water. The effect of zinc is compared with that of small quantities of metaphosphates in water treatment, and with the action of zinc in carbon dioxide metabolism in vitro.—ZDA.

8.1.4, 3.4.6, 4.3.3

Aggressiveness (of Potable Water) for Lime According to Franquin and Marecaux. CARLOS CANDIDO COUTINHO AND J. J. ANTUNES GONCALVES. *Anales Bromatol (Spain)*, 1, 235 (1949).

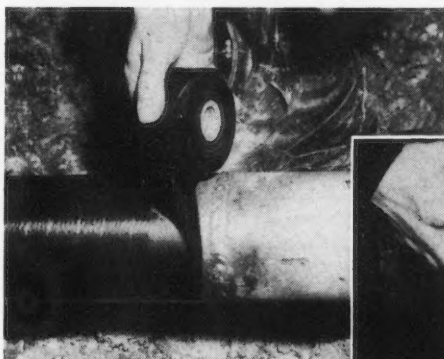
For determination of aggressiveness, determine pH, combined carbon dioxide, free carbon dioxide, calcium and residue of evaporation at 150° by the known

DRESSERTAPE ... the name that means QUALITY PROTECTION

... against corrosion

Gas men for over 50 years have known that any product bearing the Dresser name really does the job for which it is made. Before recommending Dressertape to you, we made sure it would work—give you the lasting protection you need. Now, we ask you to try it, with the same confidence you have in other Dresser products.

Dressertape can save plenty of expensive man-hours and cut your over-all costs on every job where pipe protection is required—because it's faster, simpler, more effective.



Welded joint is quickly and permanently protected by Dressertape without special surface preparation.

Complete, uniform coverage of irregular joints and fittings is easy with Dressertape. No gaps, voids or holidays.



LOOK AT THESE OUTSTANDING DRESSERTAPE FEATURES!

- Easy, clean to apply—sticks at a touch, no heating equipment required.
- Safe to use—no burns, no fumes.
- Conforms to irregular surfaces—especially over fittings on service lines.
- Immediate backfill—no waiting.
- Exceptional electrical properties—dielectric strength: 10,000 volts; insulation resistance: 100,000 megohms.
- Lasting protection against water, oil and soil chemicals—equal to or exceeding yard or mill-wrapped pipe.

• Dressertape is a trade-mark of Dresser Manufacturing Division

DRESSER®

MANUFACTURING DIVISION

Bradford, Penna.

(One of the Dresser Industries)
Warehouses: Houston, Texas and
South San Francisco, California

Gentlemen: ☐ Please send detailed information and literature about Dressertape.
☐ Please have your sales engineer call with Dressertape samples.

NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE NO. _____ STATE _____

methods. Plot sum of bicarbonate carbon dioxide and free carbon dioxide as mm./l. on abscissa. Intersection of pH curve of water with ordinate corresponding to values indicated above gives "representative point" of water. This point lies either below solubility curve of calcium carbonate (aggressive water), above curve (incrustant water), or coincides with curve (water in equilibrium). For aggressive water, pH and aggressive carbon dioxide vary with correction method applied: 1) aeration, 2) addition of calcium hydroxide or 3) addition of marble. Method 1 reduces free and thus total of free and bicarbonate carbon dioxide content and increases pH. Representative point displaced parallel to abscissa until it reaches calcium carbonate solubility curve. The pH curve passing through this point gives pH water will have when all aggressive carbon dioxide is eliminated. Distance on abscissa between representative point of water and equilibrium curve gives aggressive carbon dioxide and distance between latter curve and bicarbonate radical curve the equilibrium carbon dioxide. When Method 2 is used, representative point of water is determined as indicated above, this point joining the bicarbonate radical curve by a straight line forming a 45° angle with abscissa. Aggressive carbon dioxide given by straight line joining the representative point of solubility curve of calcium carbonate, and equilibrium carbon dioxide by the line joining curve with bicarbonate radical curve. Place of intersection of solubility curve with pH curve gives pH required by water after treatment with calcium hydroxide. With Method 3, aggressive carbon dioxide content given by difference of ordinate from representative point and intersection of solubility curve and carbon dioxide at equilibrium by difference of ordinate of latter point and point of interception with bicarbonate radical curve.—AWWA.

8.1.4, 3.6.2, 3.6.7

Electrolysis in Connected Aqueducts. D. HENDRICKSON. *Eng. News-Record*, 145, 27 (1950) Dec. 28.

Parallel operation of bituminous-coated steel pipelines can generate large galvanic currents in soil of low resistivity. Demonstrated recently when serious water leakage in the 25-year-old Mokelumne aqueduct began shortly after construction of parallel line. Electrolytic action stopped by placing insulated joints in cross connections between lines. This broke electric circuit that developed. Galvanic current of 16 amp. was discharging from bituminous-coated pipe over 2,500 ft. Current was discharging through cracks caused by soil stresses in coating. Soil was heavy adobe with resistivity as low as 200 ohms per cm. Partial explanation is that concrete-coated pipe tending toward alkaline side formed cathode. This picked up current from low-resistance soil over quite a stretch of line. Current increased as a cross-connection was approached. On other side, old bituminous-coated pipe being more acid in nature formed an anode. Current was discharged from pipeline back into ground over a long stretch.—AWWA.

8.1.4, 5.2.3

Cathodic Protection of Moving Underwater Equipment. WILLIAM S. MERRITHW. The Metropolitan Water District of Southern California, Los Angeles, Calif.

Corrosion, 8, No. 3, 90-92 (1952) Mar.

Successful operation of a cathodic protection system to safeguard moving underwater equipment at the F. E. Weymouth Memorial Water Softening and Filtration Plant of the Metropolitan Water District of Southern California is described. Two units with combined capacity of 200,000,000 gallons daily process and soften Colorado River water. Unit installed in 1941 was without cathodic protection, reliance being placed on an anticipated coating of sludge from lime treatment to retard corrosion. By 1944 it became obvious corrosion of members had progressed to a point where further protection was needed. Tests revealed protective coating plus a cathodic protection system assuming an ultimate 10 percent of bare metal surface was practical. A rectifier and iron pipe anodes were installed in 1944, those in the clarifier basins being designed to rotate with equipment. Test coupons and examinations of structure reveal complete protection with a reduction in potential ranging from 220 to 280 millivolts. One bay of 800 feet of drag chain scrapers installed in the second unit built in 1949 has an experimental installation of magnesium anodes designed to protect the chain, rails, drive shafts, etc., and the balance of the equipment has been coated only. Examination after years shows adequate protection, supports figures estimated life of anodes on cathodically protected chain.

8.2 Group 2

8.2.2, 5.3.4

Tower Footing Corrosion. WALTER J. PIPER AND JOHN D. PIPER. Paper Edison Electric Institute Transmission and Distribution Committee, Denver, Colo., May 25, 1950, and the Seventh Ann. Conf., Natl. Assoc. Corrosion Engrs., New York, N. Y., March 13-16, 1951. *Corrosion*, 7, No. 4, 134-140 (1951) Apr.

1. The measurement of the tower-to-soil potentials provides a means by which the condition of the galvanizing on underground portions of towers can be predicted with fair accuracy.

2. The electropotential measurement technique has the advantage over the chemical and visual methods of being so rapid that many towers can be checked in the time it takes to examine one by either of the other methods.

3. The potential measurement gives the over-all condition of the underground portion of the towers instead of the conditions at the relatively small areas that it is practical to expose for visual observations or chemical test.

4. The tower potentials at switching station ends of The Detroit Edison Company's transmission lines are much lower than those that are a considerable distance from the stations. Potentials are also low for those towers situated near steel poles set in concrete and grounded individually.

5. The low potential at the station ends is due in part to the fact that the grounding medium for the stations is massive steel and copper. Similarly the steel poles set in concrete are connected to grounds of either copper rods or pieces of iron.

6. The disconnection of the overhead ground wire from the station structure usually caused the potential of towers adjacent to the station to increase. In some cases the increase in potential has

been great enough to indicate that the towers are adequately protected by the galvanizing remaining on them. In other cases the potential remained low after the ground wire was insulated from the station. This indicated some other means of protection was needed.

7. Potential gradients do exist at locations other than at station ends. These gradients are usually downward in the direction of the tower having the greatest loss of galvanizing due to corrosion.

8. The potential measured is not always the true potential of an individual tower because the overhead ground wire permits nearby towers of low or higher potential to influence the potential of any individual tower.

8.3 Group 3

8.3.3, 6.4.2

Light Metal Dairy Equipment. (Milchwirtschaftliche Geräte aus Leichtmetall). E. SOLDMANN. *Eberswalder Offertenblatt* (Germany), 71, No. 22, 954-955 (1950) Nov. 25.

Aluminum dairy equipment has been used with great satisfaction in Germany for about 30 years. The use of aluminum offers the following advantages: 1) easy to clean, 2) good corrosion resistance, 3) no cracks for bacteria growth, 4) no joints for milk or cheese residues to accumulate, 5) no discoloration of milk products, 6) no flavoring of milk products, 7) dairy products can be stored for long periods without change, 8) good mechanical properties, 9) light weight. Pure aluminum and aluminum alloys are used for pails, filters, cans, barrels, ladles, knives, vats and many other types of equipment used in the transporting and processing of milk, cheese and butter. The dairy products are protected best by packaging in aluminum foil. Care should be taken to clean aluminum dairy equipment with cleaning materials recommended by the manufacturer.—ALL.

8.4 Group 4

8.4.1, 4.3.4

The Recovery of Benzole at Gasworks and at Coke Ovens. W. H. HOFFERT AND G. CLAXTON. Paper before 4th World Power Conf., London. Summer 1950. *International Chem. Eng.*, 32, No. 4, 171-175 (1951) Apr.

Discussion of oil washing, sludging of wash oil, oil washing under pressure, active carbon recovery, recovery by cooling, refining by use of inhibitors, sulfur removal, corrosion of equipment, corrosive sulfur, hydrogenation refining, sulfur removal from gas, and future trends. Since the introduction of the inhibitor process, the production of sulfur dioxide, resulting in excessive corrosion, has increased. The corrosion of copper due to elementary sulfur is influenced (in the case of benzoles) by the use of cyclopentadiene as a corrosion inhibitor. The refining of benzoles by hydrogenation methods has been devised using a nickel catalyst and moderate hydrogen pressures, but is not commercially economical. In the Carpenter-Evans process, reduction of sulfur compounds in gas to hydrogen sulfide is affected by the use of a nickel catalyst. Another process makes use of a nickel catalyst, supported on china clay pellets, to oxidize the carbon disulfide and hydrogen sulfide. A controlled amount of oxygen is admitted to the gas

which is heated to 160-180° C. before entering the catalyst. The process is one of catalytic combustion and not hydrogenation. 24 references are given.—INCO.

8.4.3, 2.3.9, 2.4.3

Corrosion of Producing Wells. Discussed in three papers presented at the A.P.I. Prod. Div. Meet., Los Angeles May 12-13, 1949. *Oil Gas J.*, **48**, No. 2, 170 (1949) May 19.

1) The report "Economics of Oil-Well Corrosion Control," R. J. Villagrana and W. W. Messick, S. O. Co. (Calif.), showed that effective and economical corrosion control can be established with methods now available to the industry. Iron counts combined with production rates were offered as a fair qualitative indication of corrosion. 2) In the paper "Detection of Incipient Drill-Pipe Failures" by W. C. Main, progress and development work in the use of the Tuboscope and of Magnaflex and Magnaglo were reviewed. Progress made with the electro-magnetic induction method promises wider use because of the rapidity with which tests can be made. 3) In "An Outline of Some Problems in Oil Well Casing Corrosion," G. N. Scott suggested a joint investigation on the part of interested companies with the topical committee of the A.P.I. as the clearing house for information.

8.4.3, 5.4.5

Refinery Painting. W. B. Cook. Paper, South Central Regional Meeting, Natl. Assoc. Corrosion Engrs., Corpus Christi, Texas, Oct. 17-20, 1951. *Corrosion*, **8**, No. 3, 93-99 (1952) Mar.

The varied conditions to which petroleum refinery equipment surfaces composed of different materials of construction are exposed are enumerated. Selection of surface preparation methods and paint coating systems to provide the best economic results for protection, decorative effect and other benefits to be derived from the application of paints and coatings to surfaces exposed to specific refinery conditions, are discussed.

8.4.3, 5.4.5, 6.2.3

Combating Marine Corrosion. *Petroleum*, **13**, No. 11, 277 (1950).

The protection of steel platforms erected in the sea for oil drilling is described. At sea level the steel piles are protected by seven anti-corrosive layers, four of which are bituminous enamels. Areas drenched by salt spray are coated with a non-drying composition containing a petroleum compound, zinc and zinc oxide. Under and well above water, zinc chromate and red lead primers and alkyd vehicle paints have been used.—RPI.

8.4.3, 5.9.2

Down-Hole Chemical Treatment to Clean Clogged Formations. *World Oil*, **150**, No. 4, 171 (1950) Mar.

A process, patented by V. D. Lawmaster, for removing paraffin and other clogging agents from the face of the pay formation in shot holes at the bottom of oil and gas wells comprises introduction of an alkali-metal hydroxide to generate heat of solution to melt the paraffin, a concentrated mineral acid to generate heat of neutralization, sulfurized quinoline as a corrosion inhibitor, a coating compound to protect the bottom of the casing and tubing, a second concentrated mineral acid and an inorganic carbonate to produce carbon dioxide for greater

penetration. A positive pressure is maintained in the well with air to keep the reactants on the pay with no dilution of the chemicals from loading with water or oil. A diagram of the apparatus is shown.

8.4.3, 7.2, 3.2.2

Prevention of Corrosion of Relief Valves in Sour Crude Oil Service. R. J. HAFSTEN. *Proc. Amer. Petroleum Inst.*, **30M**, (III), 81-86 (1960); discussion 87.

Relief-valve springs failed as a result of hydrogen embrittlement caused by the liberation of hydrogen from the reaction between H_2S and iron. Metallizing with aluminum overcame this trouble. Corrosion of 17-20 percent chromium steel disc guides presented a serious problem because the build-up of corrosion products prevented the valves from functioning effectively. The use of disc guides electroplated with 0.002-0.003 in. of hard chromium proved to be a satisfactory solution.—MA.

8.4.5

Oxidation Potentials of the Pu (III)-Pu(IV) and Fe (II)-Fe(III) Couples in Perchloric Acid Solution—Heat Content and Entropy Changes. ROBERT E. CONNICK AND WILLIAM H. McVEY. *J. Am. Chem. Soc.*, **73**, 1798-1804 (1951) Apr.

The formal potential of the cell $Pt:H_2:1M HClO_4, Pu(ClO_4)_3, Pu(ClO_4)_4$ Au was found to be -0.982 volt at 25° C. This value differs significantly from that previously reported and is consistent with the idea that Pu^{4+} is partly complexed by chloride ion in 1M HCl. A formal potential scheme involving the +3, +4, and +6 oxidation states of Pu in 1M $HClO_4$ was derived. The emf was measured as a function of temperature, and the change in heat content for the reaction $Pu^{3+} + H^+ = Pu^{4+} + \frac{1}{2}H_2$ was found to be $+13.52$ kcal/mole, compared with 13.3 kcal/mole obtained by Evans ("The Transuranium Elements," New York, McGraw-Hill, 1949, p. 282) from calorimetric measurements. Approximate entropy values for the ions Pu^{4+} and PuO_2^{2+} were found to be -77 and -18 units, respectively. These are very nearly equal to those for the corresponding ions of U. The heat and free energy of the reaction $Fe^{2+} + H^+ = Fe^{3+} + \frac{1}{2}H_2$ were measured and compared with previously determined values.—NSA.

8.8 Group 8

8.8.5, 3.7.3

Fundamental Aspects of the Cold Working of Metals. MAURICE COOK AND T. L. RICHARDS. *J. Inst. Metals*, **78**, 463-482 (1951) Jan.

Discusses nature of the metallic state and metallic cohesion in terms of the electron theory of metals. Gives a brief outline of the various mechanisms involved in plastic deformation. These include crystallographic slip, twinning and kinking and a shear mechanism to which particular attention is drawn because of its importance in many metal-fabrication processes. The influence of plastic deformation on structure is described with special reference to the development of preferred orientation. The effect of deformation on fine structure as revealed by X-ray diffraction and the relation of work-hardening and plasticity to structural changes brought about by cold working are also discussed. 37 references.—BLR.

INDEX TO ADVERTISERS

Vol. 8 September, 1952 No. 9

	Page
Aluminum Company of America	17
Amercoat Corporation	Inside Front Cover
American Cast Iron Pipe Co.	18
American Chemical Paint Co.	27
Bakelite Company, Union Carbide & Carbon Corp.	41
Bechtel Corp. & H. C. Price Co.	x
Branche-Kracy Co., Inc.	37
Calgon, Inc.	21
Carpenter Alloy Tube Div.	xi
Centriline Corp.	8
Coast Paint & Lacquer Co.	10
Corrosion Directory	35
Dampney Co., The	ix
Day, S. D. Co.	ix
Dow Chemical Co.	ii
Dresser Industries, Inc.	45
Electro Rust-Proofing Corp.	vi
Equipment Manufacturers of N. J.	29
Federated Metals Division, American Smelting & Ref. Co.	15
Glass Fibers, Inc.	i
Good-All Electric Mfg. Co.	xiv
Harco Corporation	11
Harper, H. M. Co.	6
Hill, Hubbell & Co., Division of General Paint Co.	48
Insul-Mastic Corp.	13
Johns-Manville Sales Corp.	vii
Koppers Company	xv, 324
Mayer Bros.	39
Metallizing Engineering Co., Inc.	xii
Michigan Pipe Co.	4
Minnesota Mining & Mfg. Co.	19
Mutual Chemical Co. of America	12
Natasco Co., The	24
National Association of Corrosion Engineers	5, 12, 16
National Carbon Company, Union Carbide & Carbon Corp.	9
Nelson Electric Mfg. Co.	14
Nicolet Industries, Inc.	7
Pennsylvania Salt Mfg. Co.	13
Pittsburgh Coke & Chemical Co.	Inside Back Cover
Plastic Engineering & Sales Corp.	16
Positions Wanted	12
Reilly Tar & Chemical Co.	3
Saran Lined Pipe Co.	25
Service Engineers, Inc.	26
Standard Magnesium Corp.	20
Standard Pipeprotection, Inc.	28
Stearns, D. E. Co.	Back Cover
Tapecoat Co., The	32
United States Stoneware Co.	22
Williamson, T. D., Inc.	xiii



Save Maintenance Expense

Pipe coated and wrapped by Hill, Hubbell is insurance against unnecessary maintenance expense.

Hill, Hubbell protected pipe lasts longer because we have absolute control over every step of the process. First the pipe is cleaned metal-bright with Roto-Grit Blast. All coatings and wrappings are precision applied at uniform temperatures. Every length is inspected with electronic holiday detectors before leaving the factory.

Hill, Hubbell and Company
 Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

PLANTS

Lorain, Ohio; Youngstown (at Girard, Ohio); Chicago Area—Hammond, Indiana (Gibson Yard) ★

★ Railroad in transit privileges

**Leaders in
 Pipe Protection
 for a
 Quarter Century**

Vol. 8

"We get better "mileage" with PITT CHEM Enamels!"



DOPE MEN know that it takes an enamel with top application characteristics to keep their machines eating up the miles at top speed. And that's one big reason why they prefer Pitt Chem. They've learned from experience that Pitt Chem Enamels heat up faster, flow better from kettle to pipe, and coat more pipe per ton because of their consistent peak quality and uniform bond. What's more, Pitt Chem's consistently better bond means *better, longer-*

lasting protection underground.

We're able to offer these advantages because of Pittsburgh Coke & Chemical's *basic* and *integrated* production facilities. Our careful and exacting quality-control extends from coal, through each step of production, to the finished enamels. So when you're specifying pipe-line enamels, *buy basic—buy Pittsburgh*—and be sure of better protection at lower cost.

- ★ Standard Grade Tar Base Enamel
- ★ Modified Grade Tar Base Enamel
- ★ Plasticized Grade Tar Base Enamel
- ★ Cold Applied Tar Base Coatings

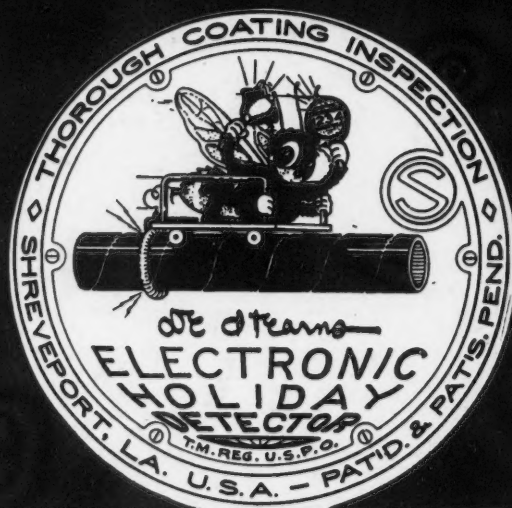


PROTECTIVE COATINGS DIVISION
PITTSBURGH
COKE & CHEMICAL CO.

Grant Building • Pittsburgh 19, Pa.

WAD 4207

★ Thorough Inspection ★ Light Weight
★ Simple to Operate ★ Dependable Service



The D. E. STEARNS Co.
SHREVEPORT, LOUISIANA

POST OFFICE BOX 1234

A Dependable Organization
providing the
Finest Holiday Detector Equipment
for the
Entire Pipe Line Industry

Via Air - Anywhere

▲ BETTER COATINGS CONSERVE STEEL ▼

ht
ice